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The Department of Defense

DEPARTMENT/AGENCIES PARTICIPATING:

Department of the Army

Department of the Navy

Department of the Air Force

Defense Advanced Research Projects Agency

Defense Nuclear Agency

Strategic Defense Initiative Organization

PROGRAM SOLICITATION 89.1

Closing Date: 6 January 1989

FY-1989 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION
Number 89.1
Small Business
Innovation Research
Program

Issue Date: October 1, 1988

U. S. Department of Defense

SBIR Program Office

Washington, DC 20301

Closing Date: January 6, 1989

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DEPARTMENT OF THE AIR FORCE

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1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Nuclear Agency (DNA), and Strategic Defense Initiative Organization (SDIO), hereafter referred to as DOD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to availability of funds, DOD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense related scientific or engineering problems.

Objectives of the DOD-SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or research and development results.

The Federal SBIR Progam is mandated by Public Laws PL 97-219 and PL 99-443. The basic design of the DOD SBIR program is in accordance with the Small Business Administration (SBA) Policy Directive, #65-01.2. The DOD program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DOD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD. Results from prior years are shown in Reference A at the back of this solicitation.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219 and PL 99-443. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DOD support in Phase II. The measures of Phase I success include evaluations of the extent of which Phase II results have the potential to yield a product or process of continuing importance to DOD. Proposers are asked to consider whether the research and development they are proposing to DOD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the Government funded research and development phases.

Subsequent Phase II awards will be made to firms only on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the research or development. Also, under Phase III, federal agencies may award non SBIR-funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed in part, to provide incentives for the conversion of federally-sponsored research and development innovation in the private sector. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DOD is not obligated to make any awards under either Phase I, II or III. DOD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-on Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DOD supported research or research and development into technological innovation by private firms. Therefore, on an optional basis, the DOD program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting the DOD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DOD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in this solicitation Section 5.7.

1.4 Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the cover sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the several states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in this solicitation.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DOD component for further guidance.

1.6 Contact with DOD

a. **Oral Communications.** Oral communications with DOD Components regarding this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness, with the exceptions as stated in Section 1.6, 7.0, and Appendix D of this program solicitation.

b. **Contacts for General Information on This Solicitation.** General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(202) 697-1481

Other non-technical questions pertaining to a specific DOD Component should be directed in accordance with instructions given at the beginning of that DOD Component's topics in Appendix D of this solicitation.

c. **Requests for Additional Copies of This Solicitation.** Additional copies of this solicitation may be ordered from the Defense Technical Information Center: Attn: DTIC/SBIR, Building 5, Cameron Station, Alexandria, Virginia 22304-6145; (telephone (800) 368-5211 (toll free)/(202) 274-6902 (commercial for Virginia, Alaska and Hawaii).

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Any activity which is (A) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (B) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (C) a systematic application of knowledge towards the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. In DOD's R&D Program the definitions A, B, and C above correspond respectively as follows: (A) Basic Research, (B) Exploratory Development, and (C) Advanced Development or Engineering Development.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 U.S.C. 661, et seq., are affiliates of one another when either directly or indirectly (A) one concern controls or has the power to control the other; or (B) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Minority and Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and

b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small businesses, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups: Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or Asian-Indian Americans.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51 percent owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a federal Government contract awardee calling for supplies or services required solely for the performance of the original contract.

3.0 PHASE I PROPOSAL PREPARATIONS INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DOD Component under the SBIR program is to provide sufficient information to persuade the DOD Component that the proposed work represents a sound approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

Those responding to this solicitation should contact the Defense Technical Information Center (DTIC) for scientific and technical information assistance as described in Section 7.0. Background information available from DTIC on each of the topics listed in Appendix D can facilitate better informed decisions to bid or not to bid and may enhance the technical quality of a proposal by demonstrating more thorough knowledge of related work already completed or underway by DOD Components and others.

A proposal should be self-contained and written with care and thoroughness. Each proposal should be reviewed carefully by the offeror to ensure inclusion of all data essential for evaluation.

If a proposal is substantially the same as the one submitted in response to this solicitation has been previously funded or is either funded by, pending with, or about to be submitted to another federal agency or another DOD Component, or to the same DOD Component as a separate action, the proposer must so indicate and provide the information required by Section 3.4.1 and on Appendix A.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the DOD program objectives, but can also serve as the base for technological innovation, new commercial products, process, or services which benefit the public.

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, (no type smaller than elite on standard 8 1/2" X 11" paper with one (1) inch margins, 6 lines per inch) *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project-related discussion is discouraged. Cover all items lised below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25-page limitation will be considered in proposal evaluation, and proposals in excess of the 25-page limitation *will not* be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss briefly as described in Section 3.4, items b and h.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered.

a. Cover Sheet. Photocopy and complete the form in Appendix A as page 1 of each copy of each proposal.

b. Project Summary. Photocopy and complete the form identified as Appendix B as page 2 of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, *will not* contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Briefly describe:

(1) Whether and by what means the proposed project appears to have potential use by the federal Government.
(2) Whether and by what means the proposed project appears to have potential commercial application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of two-thirds of each SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another federal agency or DOD Component or the same DOD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DOD Component to which a proposal was submitted, or will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each pending SBIR proposal submitted or award received.

Note: *If Section 3.4.1 does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."*

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DOD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. They may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds, will be vested with the DOD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DOD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DOD Component based upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DOD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DOD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government contracting officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DOD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, or research and development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DOD.

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals.

4.2 Evaluation Criteria - Phase I

The DOD Components plan to select for award those proposals offering the best value to the Government with approximately equal consideration given to each of the following criteria, except for item a., which will receive twice the weight of any other item:

a. Scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.
b. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.
c. Anticipated benefits of the research or research and development to the total DOD research and development effort.
d. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred-to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is not initiated by a solicitation but must contain a project summary sheet in the format of Appendix B of this solicitation. Instructions regarding Phase II proposal submission will be provided by DOD Components to all Phase I award winners at time of contract award. Listed below are some of the principles upon which those instructions can be expected to be based.

A Phase II proposal can be submitted at any time when progress attained under Phase I is deemed sufficient to justify the effort to be proposed for Phase II. (See Section 5.2.) It must contain enough information on progress accomplished under Phase I by the time of Phase II proposal submission to enable an evaluation of the project's promise if continued into Phase II. The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item a., which will receive twice the value of any other item:

a. Scientific/technical quality of the proposal, with special emphasis on its innovation and originality.
b. Qualifications of the principal investigator and other key personnel to carry out the proposed work.
c. Anticipated benefits of the research or development to the total DOD research and development effort.
d. Degree to which the Phase I objectives were met at the time of Phase II proposal submission.
e. Adequacy of the Phase II objectives to meet the opportunity or solve the problem.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for a continued development from non-federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by Government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

5.1 Awards (Phase I)

a. **Number of Phase I Awards.** The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 6, 1989. The names of those firms selected for awards will be announced. *The DOD Components anticipate making 1200 Phase I awards during Fiscal Year 1989.*

b. **Type of Funding Agreement.** Winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects. *Note: The firm fixed price contract is the preferred type for Phase I.*

c. **Average Dollar Value of Awards.** DOD Components will make Phase I awards to small businesses typically of one-half person-year effort over a period generally not to exceed six months, *subject to negotiation*. The legislative history of PL 97-219 and PL 99-443 clearly envisioned a large number of Phase I awards up to $50,000 each, *adjusted for inflation*.

5.2 Awards (Phase II)

a. **Number of Phase II Awards.** The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DOD Components anticipate making 450 Phase II awards during Fiscal Year 1989.*

b. **Type of Funding Agreement.** Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafteer as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the Government to award a Phase II contract.

c. **Average Dollar Value of Awards.** Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific and technical merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, *subject to negotiation*. The legislative history of PL 97-219 and PL 99-443 clearly envisioned that the Phase II awards would be up to $500,000 each, *adjusted for inflation*.

5.3 Reports

Six copies of a final report on the Phase I project must be submitted to the DOD Component in accordance with the negotiated delivery schedule. This will normally be within thirty days after completion of the Phase I technical effort. The final report shall include a completed DD Form 1473, *"Report Documentation Page"* as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. The summary may be published by DOD and

therefore must not contain proprietary or classified information. The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon negotiations between the DOD and the successful Phase I offeror. Based on negotiations, successful offerors may be paid under applicable authorized progress payment procedures or in accordance with a negotiated price and payment schedule. Phase I contracts are primarily fixed price in nature under which monthly progress payments may be made up to 80 percent of the billing including an allowance for profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data, which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information of data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term *"confidential proprietary information"* and provided that the following legend appears on the title page of the proposal:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the contract. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) _____ __ of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DOD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DOD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DOD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DOD support. DOD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and

requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the Government shall have the limited right to use such data for Government purposes and shall not release such data outside the Government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the Government shall retain a royalty-free license for Government use of any technical data delivered under an SBIR contract whether patented or not.

5.9 Cost Sharing

Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Paragraph 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The Government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work inaccordance with applicable regulations.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The Government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR program is not a substitute for existing unsolicited proposal mechansims. Unsolicited proposals will not be accepted under the SBIR program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DOD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

Five (5) copies of each proposal or modification will be submitted, in a single package, as described below.

6.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DOD Component address which is identified for the specific topic in that Component's section of Appendix D to this solicitation.

One copy must be an original signed by the principal investigator and an official empowered to commit the proposer. Other copies may be photocopied.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DOD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal should be sent in the same package. Do not send separate "information" copies or several packages containing parts of the single proposal.

6.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DOD Component is 2:00 p.m. local time, January 6, 1989. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than December 31, 1988 or (b) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late received proposal sent either by registered mail or certified mail is the U.S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term "postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U.S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye "postmark" on both the receipt and the envelope or wrapper; (b) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal to award. (NOTE: the term "telegram" includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding

the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.3 Notifications of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed and stamped envelope and a copy of the notification form (Reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DOD Component whose address is associated with each topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DOD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DOD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DOD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DOD-sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requestors who responded to previous DOD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DOD-funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DOD-sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DOD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 368-5211 (Toll Free)
(202) 274-6902 (Commercial for Virginia, Alaska and Hawaii)

DTIC Boston On-Line Service Facility
DTIC-BOS
Building 1103, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
AFWL/SUL Bldg. 419
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4320
(213) 355-4170

Use Reference C at the back of this solicitation to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible. Requests received after mid-December are frequently subject to mailing delays.

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

Aerospace Research Applications Center
P.O. Box 647
Indianapolis, IN 46223
(317) 264-4644

Central Industrial Applications Center
Southeastern Oklahoma State University
Durant, OK 74701
(405) 924-6822

Information Strategists
814 Elm Street
Manchester, NH 03101
(603) 624-8208

NASA/Florida State Technology Applications Center
State University System of Florida, Progress Center
1 Progress Blvd. Box 24
Alachua, FL 32615
(904) 462-3913

NASA Industrial Applications Center
823 William Pitt Union
University of Pittsburgh
Pittsburgh, PA 15260
(412) 648-7000

NASA/UK Technology
University of Kentucky
109 Kinkead Hall
Lexington, KY 40506
(606) 257-6322

NERAC, Inc.
1 Technology Drive
Tolland, CT 06084
(203) 872-7000

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

North Carolina Science and Technology Research Center
Post Office Box 12235
Research Triangle Park, North Carolina 27709
(919) 549-0671

Western Research Applications Center (WESRAC)
University of Southern California
3716 S. Hope Street #200
Los Angeles, California 90007
(213) 743-6132

7.3 Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference D at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCAS Activities.)

8.0 TECHNICAL TOPICS

Topics for each DOD Component are listed and numbered separately. Topics, topic descriptions, and addresses of organizations to which proposals are to be submitted are provided in Appendix D. Also included in Appendix D are instructions for contacting each DOD Component.

APPENDIX A
DOD No. 89.1

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PHASE 1—FY 1989
PROPOSAL COVER SHEET

Topic Number: ______ ☐ Army ☐ Navy ☐ Air Force ☐ DARPA ☐ DNA ☐ SDIO

Proposal Title: ____

____

Submitted By: Firm ____

Address ____

City ______________________ State ______ Zip Code ______

Submitted To: (Activity identified with the topic) ______________________

____

Address ____

City ______________________ State ______ Zip Code ______

Small Business Certification:

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C. 631 and in the Definition Section of the Program Solicitation.

The above firm certifies that it qualifies as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement. Yes _____ No _____.

The above firm certifies that it qualifies as a woman-owned small business firm : Yes _____ No _____.

This proposal has been submitted to other US Government agency/agencies: or DOD components, or the same DOD component. If SBIR proposal, list Topic Number.

Yes ________ ; Name(s) ____

No ________

Disclosure permission statement as follows:

All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? Yes _____ No _____.

Number of employees including all affiliates (average for preceding 12 months): ________

Proposed Cost (Phase I): ________ Proposed Duration: _____ months (not to exceed six months).

Project Manager/Principal Investigator	Corporate Official (Business)
Name ______________________	Name ______________________
Title ______________________	Title ______________________
Signature ______________________	Signature ______________________
Date ______________________	Date ______________________
Telephone ______________________	Telephone ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) ________ of this proposal. Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

Nothing on this page is classified or proprietary information/data

APPENDIX B
DOD No. 89.1

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PHASE 1—FY 1989
PROJECT SUMMARY

Topic No. ________ Military Department/Agency ________.

Name and Address of Proposing Small Business Firm

Name and Title of Principal Investigator

Proposal Title

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

Nothing on this page is classified or proprietary information/data

U.S. DEPARTMENT OF DEFENSE

DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PHASE I—FY 1989
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DOD *Solicitation Brochure*.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DOD Solicitation Brochure
6. Total Dollar amount of the proposal (dollars)
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost) (dollars)
   d. Total direct material (dollars)
8. Material overhead (rate _____%) × total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type.
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost.
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at Government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per Diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars)
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United States Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone/extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-free or firm-fixed price.

APPENDIX D

Technical Topics

Topics for each DoD components are listed and numbered seperately along with instructions for submission of pfoposals:

U.S. ARMY

INTRODUCTION

The Army awarded over 800 contracts as a result of the last three years' solicitations. As a result, approximately 350 projects are planned for conversion to Phase II, which will require most of the fiscal year 1989 funds. As a consequence, the Army portion of this year's solicitation is greatly reduced compared with previous years.

SBIR proposals must be prepared with care. Read the topics carefully and respond only to those in which you have expertise. Your proposal should be unique and innovative and should contain sufficient detail to permit a determination that the Army's support would be worthwhile and that the proposed work could benefit the Army's research and development or other mission responsibilities. Take care to observe the page limits, the due date, and the proper mailing address (see following pages).

Inquiries of a general nature or where a problem may exist that requires the Army SBIR program manager's attention may be addressed to—

Commander
U.S. Army Laboratory Command
ATTN: AMSLC-TP-TI (J. Patrick Forry)
2800 Powder Mill Road
Adelphi, MD 20783-1145
(202) 394-4602

In no case should proposals be sent to the above address.

ARMY SBIR MAILING LIST
1989

TOPIC A89-001
Commander
U.S. Army Armament Research and Development
and Engineering Center
ATTN: SMCAR-AST
Bldg 1, SBIR Program
Picatinny Arsenal, New Jersey 07806-5000

TOPIC A89-002
Commander
U.S. Army Chemical Research, Development
and Engineering Center
ATTN: AMSMC-PC-B(A)
Procurement Directorate
Edgewood Site/Bldg E4455
Aberdeen Proving Ground, MD 21010-5423

TOPICS A89-003 through 022
Commander
U.S. Army Aviation Systems Command
ATTN: AMSAV-PSAZ
Bldg 102, SBIR Program
4300 Goodfellow Blvd
St. Louis, MO 63120-1798

TOPIC A89-023
Director
U.S. Army Research Office
ATTN: SLCRO-ZC, SBIR Program
P.O. Box 12211
Research Triangle Park, NC 27709-2211

TOPIC A89-024
Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR
SBIR Program
White Sands Missile Range, NM 88002-5031

TOPIC A89-025
Commander
U.S. Army Armament, Munitions and Chemical Command
Procurement Directorate
ATTN: AMCMC-PCM(A), SBIR Program (BRL)
Edgewood Site, Bldg E4455
Aberdeen Proving Ground, MD 21010-5423

TOPIC A89-026
Director
U.S. Army Electronics Technology and Devices Laboratory
ATTN: SLCET-E, SBIR Program
Ft. Monmouth, NJ 07703-5000

TOPIC A89-027
Director
U.S. Army Harry Diamond Laboratories
ATTN: SLCHD-PO-P
SBIR Program
2800 Powder Mill Road
Adelphi, MD 20783-1197

TOPIC A89-028
Commander
U.S. Army Armament, Munitions and Chemical
Command
Procurement Directorate
ATTN: AMCMC-PCA(A), SBIR Program (HEL)
Edgewood Site, Bldg E4455
Aberdeen Proving Ground, MD 21010-5423

TOPIC A89-029
Director
U.S. Army Materials Technology Laboratory
ATTN: SLCMT-TMP, Management Branch
405 Arsenal Street
Bldg 131, Rm 144, SBIR Program
Watertown, MA 02172-0001

TOPIC A89-030
Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR, SBIR Program
White Sands Missile Range, NM 88002-5031

TOPIC A89-031
Commander
U.S. Army Belvoir RD&E Center
ATTN: AMSTR-PBP, SBIR Program
Bldg 314, Procurement Receptionist
Ft. Belvoir, VA 22060-5606

TOPIC A89-032
Commander
U.S. Army Natick Research and Development
and Engineering Center
ATTN: AMSTR-PW, SBIR Program
Natick, MA 01760-5011

TOPICS A89-033 through 045
Commander
U.S. Army Missile Command
ATTN: AMSMI-PC-LA
Bldg 4488, SBIR Program
Redstone Arsenal, AL 35898-5280

TOPIC A89-046
Commander
U.S. Army Tank-Automotive Command
ATTN: AMSTA-IRSA
Bldg 200A, SBIR Program
Warren, MI 48397-5000

TOPICS A89-047 through 048
Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR, SBIR Program
White Sands Missile Range, NM 88002-5031

TOPIC A89-049
Commander
U.S. Army Aberdeen Proving Ground Support Activity
ATTN: STEAP-PR-S, SBIR Coordinator
Ryan Bldg, Rm 124
Aberdeen Proving Ground, MD 21005-5059

TOPICS A89-050
Commander
U.S. Army Yuma Proving Ground
Directorate of Contracting
ATTN: STEYP-CR, SBIR Program
Bldg 2100, Rm 11
Yuma, AZ 85365-9102

TOPIC A89-051
Commander
U.S. Army Electronic Proving Ground
ATTN: STEEP-MO, SBIR Program
Greely Hall
Ft. Huachuca, AZ 85613-7110

TOPIC A89-052
Commander
U.S. Army Dugway Proving Ground
Directorate of Contracting
ATTN: STEDP-DOC, SBIR Program
Dugway, UT 84022-5000

TOPICS A89-053 through 055
Commander
U.S. Army Communications-Electronics
Command
ATTN: AMSEL-PC-BID, SBIR Program
Tinton Avenue
Ft. Monmouth, NJ 07703-5000

TOPIC A89-056
Director
U.S. Army Center for Signals Warfare
ATTN: AMSEL-RD-SW-OS
SBIR Program (Dr. Royal Burkhardt)
Vint Hill Farms Station
Warrenton, VA 22186-5100

TOPIC A89-057
Director
U.S. Army Center for Night Vision and Electro-Optics
ATTN: AMSEL-RD-NV-RM-PI
SBIR Program (N. Sampsell)
Ft. Belvoir, VA 22060-5677

TOPICS A89-058 through 061
Commander
U.S. Army Construction Engineering Research
Laboratory
ATTN: Chief, Procurement & Supply Branch
2909 Newmark Drive
Bldg #1, Rm 175-1, SBIR Program
Champaign, IL 61820-1305

TOPICS A89-062 through 063
Commander
U.S. Army Engineer Topographic Laboratories
ATTN: CEETL-PR-PM, SBIR Program
Bldg 2592
Ft. Belvoir, VA 22060-5546

TOPIC A89-064
Commander
U.S. Army Engineer Waterways Experiment
Station
ATTN: CEWES-BC
SBIR Program (M. Holman)
P.O. Box 631
Vicksburg, MS 39180-0631

TOPIC A89-065
Commander
U.S. Army Cold Regions Research and
Engineering Laboratory
ATTN: CRREL-AL, SBIR Program
72 Lyme Road
Hanover, NH 03755-1290

TOPICS A89-066 through 069
Commander
U.S. Army Research Institute for Behavioral and Social Sciences
ATTN: PERI-BR, SBIR Program
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

TOPICS A89-070 through 084
Commander
U.S. Army Medical Research Acquisition Activity
ATTN: SGRD-RMA-RC, SBIR Program
Ft. Detrick, Bldg 820
Frederick, MD 21701-5014

TOPICS A89-085 through 086
Director
U.S. Army Institute for Rearch in Management Information, Communications, and Computer Science (AIRMICS)
ATTN: ASBG-C (Dr. C. Ronald Green)
115 O'Keefe Building, Geogia Tech
Atlanta, GA 30332-0800

A89-001 Advanced Seekers for Smart Munitions

A89-002 Sorbents for Decontamination of Chemical Warfare Agents

A89-003 Rotorcraft Tactics Expert and Mission Management System

A89-004 Fatigue Life Monitor (non-airframe)

A89-005 Passive Personal Cooling Vest

A89-006 Simultaneously Radiated Multiple Frequency Susceptibility Testing of Aircraft

A89-007 Field Repairable Composite Airframe Structures

A89-008 Mach-Scale Remote Control Rotorcraft Technology

A89-009 Innovative Rotor High Lift Concepts for Helicopter Super Maneuverability

A89-010 Smooth, Erosion Resistant Coatings for Organic Matrix Composites

A89-011 Updating Current Electro-Magnetic Interference/Electromagnetic Compatibility (EMI/EMC) Test Methods and Equipment

A89-012 Superplastic Forming and Diffusion Bonding of Cylindrical Casings

A89-013 Interactive Exterior Helicopter Coating for Enhanced Ballistic Tolerance

A89-014 Model for Determining Effectiveness of Rockets with Multiple Kinetic Penetrators

A89-015 Unique Gas Turbine Combustor Aerodynamics

A89-016 Automated Fiber-Reinforced Thermoplastic Fiber Placement

A89-017 Rotor Performance Prediction Capability Using Advanced Aerodynamic Methods

A89-018 Fire Retardant Coatings for Aramid Fibers

A89-019 Integrated Composite Flow Casting

A89-020 Direct Electric Tail Rotor Integrated Drive (DETRID) System for Helicopters

A89-021 Airbag Crash-Protection Concepts for Single Cockpit Helicopters

A89-022 Crashworthy Crewseat Designs Having a 20-Degree Seat Back Angle

A89-023 Optimum Imagers For Image Processing

A89-024 Ultraviolet Light Detection and Ranging (LIDAR) as a Remote Sensor

A89-025 Interaction Of Shaped-Charge Devices With Electromagnetic Fields

A89-026 High-Temperature Superconductivity

A89-027 Dual-Polarization 95-GHz Planar Antenna

A89-028 Effect of Speech Intelligibility on Performance: Testing in Operational Settings

A89-029 Joining of Composite Materials and the Nondestructive Evaluation/ Characterization of the Resultant Joints

A89-030 Air Defense and Space Systems Electronic Warfare (EW) Vulnerability

A89-031 Development of Ultrasonic Inspection Method for Heavy-Section Organic Composites

A89-032 Improved Polymers for Adhesives for Bonding Selected Elastomers

A89-033 Improvement of Test Instrumentation for Filament-Wound Structures

A89-034 Antenna Cross-Coupling in a Damped Resonant Cavity

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A89-085 Distributed System Simulation Performance Improvements Through New Algorithmic Modeling and Hardware Architectures

A89-086 Decision Making In A Geographically Distributed Environment

ARMAMENT RDE CENTER

A89-001

TITLE: Advanced Seekers for Smart Munitions

OBJECTIVE: Develop new and improved smart munitions seekers.

DESCRIPTION: The U.S. Army Research, Development and Engineering Center (ARDEC) has committed itself to developing an evolutionary family of both "shoot to kill" as well as "hit to kill" smart projectiles munitions throughout the foreseeable future. Past examples of this thrust are seen in the copperhead projectile currently in production, as well as search-and-destroy armor (SADARM) now in full scale development. Seekers and sensors in future munitions will be faced with increasingly complex decision making situations, and they must also be producible, affordable, and packageable into existent envelopes of constraint.

These munitions will rely on increasingly autonomous seekers capable of finding a variety of ground and air targets immersed in terrain/background situations. Infrared (IR), millimeter wave (MMW), and laser technologies form the conventional baseline approaches. In addition, acoustic and active laser radar bands could be used. Combinations of these bands will provide a continual stream of signals representing space-time maps of the world, at state-of-the-art resolution levels. Present seekers are limited in their performance against complex backgrounds, weather adversities, and counter- measures, and their performance must be enhanced. Examples are hybrid semi-active laser (SAL)/infrared (IR) seekers, focal plane array/ imaging IR seekers, strapdown IR/MMW seekers, advanced MMW integrated circuit seekers, and dual-mode IR/MMW seekers.

ARDEC is also interested in cost and producibility issues involving the above and: uncooled IR detectors, longwave IR focal plane arrays, low-cost optical trains, ruggedness of IR/optical components, conformal phased antenna arrays, signal-processing hardware, high-repetition rate laser diodes, and tunable/switchable IR filters.

The pattern-recognition challenge goes hand in hand with the hardware challenge. The seeker must detect, identify, classify, and track the desired target(s) in an unpredictable and complex set of data. To make this feasible, hardware advances in large-scale integrated circuits (LSIC), optical computers, and parallel-processing architectures must be tied together with advances in algorithms and artificial intelligence disciplines.

CHEMICAL RDE CENTER

A89-002

TITLE: Sorbents for Decontamination of Chemical Warfare Agents

DESCRIPTION: Of the technologies evaluated in the Army Decontamination Master Plan, sorbents offered the greatest promise for operational advantage to the individual soldier in the field. At the moment many countries in the world have as standard small decontamination kits some variant of a sorbent technology. Fuller's earth or diatomaceous earth are the most common. The US, however, does not now have a sorbent based kit. The reasons for that are many. Sorbents have limited

capacity, typically 25% by weight or less of liquid chemical agent can be adsorbed, and provide no destruction of the agent. As a consequence, the used material is hazardous itself and clean-up of large amounts of liquid requires much material.

Thus, sorbents or solids are required that will react with the chemicals they adsorb. Ideally this reaction should be catalytic so that little sorbent would be required to destroy the agent; this opens the possibility of materials that could be reused, thereby reducing the logistic impacts. To be useful the sorption must be fairly fast to pick up the liquid quickly. The reactions could then proceed at a somewhat slower pace if, when they were complete, the surface would be ready to adsorb more agent.

Phase I objectives will concentrate on identifying candidate sorbents to meet Army requirements. Those sorbents identified in Phase I will be evaluated in Phase II individually and in conjunction with catalytic materials.

AVIATION SYSTEMS COMMAND

A89-003

TITLE: Rotorcraft Tactics Expert and Mission Management System

DESCRIPTION: Automated systems using artificial intelligence (AI) techniques are currently needed to simulate advanced in-flight pilot decision aiding concepts in research environments such as the NASA/Army Crew Station Research and Development Facility. Such intelligent decision aiding systems are a recognized requisite for mission effectiveness in advanced Scout/Attack helicopters such as LHX. They are envisioned to provide the pilot or crew with on-board planning, situation awareness, tactics and systems- monitoring advisory capabilities. In addition, these knowledge-based systems are required to interface with advanced cockpit displays and controls so as to allow pseudo-natural dialog by means of inferences about the pilot's intent. Areas requiring innovative research include: (a) Development of a cooperative knowledge based systems structure to support simulation of on-board tactics expert, situation awareness, and other mission-management functions. (b) Development of an intelligent pilot-vehicle interface concept predicated on a knowledge base of the helicopter pilot's intentions and natural language techniques. (c) Development of mathematical and logical structures for representing multi-attribute resource values and mission objectives to support planning, tactics expert or situation awareness functions in a combat threat environment. Phase I will involve a detailed study effort and prototype development. Phase II will provide a working version of the concept that will allow fully integrated use within the NASA/Army Crew Station Research and Development Facility.

A89-004

TITLE: Fatigue Life Monitor (non-airframe)

DESCRIPTION: Define concept to determine life remaining of non-airframe dynamic components (i.e., shaft, gears and bearings) to improve maintenance scheduling. Concept should be defined by algorithms available, baseline dataavailable, sensors and on-aircraft processing requirements, data management and display of decisions. The product of Phase II will be the fabrication of the system, aircraft installation, and field tests.

A89-005

TITLE: Passive Personal Cooling Vest

DESCRIPTION: A passive personal cooling vest would maintain acceptable aircrew core temperatures while wearing ballistic and/or nuclear/biological/chemical (NBC) protective clothing. The cooling vest should perform both inside and outside the aircraft. The most desirable design would utilize passive cooling at all times, although active cooling while in the aircraft is acceptable. Passive cooling implies heat transfer away from the crew's core without an external energy source. An example of a passive cooling clothing is the robe worn by desert nomads. An example of active cooling is portable power pack and cooling system utilized by NASA astronauts between ground control and the launch system. Advantages of this passive system might include cost, weight, and simplicity. The major advantage would be the capability of long-term escape and evasion in a contaminated, combat environment.

A89-006

TITLE: Simultaneously Radiated Multiple Frequency Susceptibility Testing of Aircraft

OBJECTIVE: Investigate the validity, of and the methods for, simultaneously radiated, multiple frequency susceptibility testing of aircraft and aircraft components as well as the risks incurred if the testing is not performed.

DESCRIPTION: Current susceptibility testing of Army aircraft and aircraft components involves the radiating of the unit under test with an electromagnetic signal that is at a discrete frequency while monitoring the system for susceptibility. This is done at a set of frequencies or while a frequency sweep is conducted over the required frequency range. With the increasing use of components and materials that exhibit nonlinear electromagnetic effects, the responses of these components and materials to multiple signals that are at different frequencies are difficult to predict. Because of this, the validity of the standard approach of radiating the aircraft or components with only one signal is being questioned. The concern now is whether or not the aircraft and components should be tested using simultaneously radiated multiple signals at differing frequencies. Phase I of this project would be to determine whether the traditional method of susceptibility testing is valid or if simultaneously radiated multiple frequency susceptibility testing should be performed. The analysis should include a description of the additional information that would be obtained from this testing as well as the risks incurred by the Army by not performing this testing. Phase II would be to develop the methods for this testing. This would include development of pretest analysis methods, the actual test methods including a description of the types of equipment and facilities required, and post-test analysis methods.

A89-007

TITLE: Field Repairable Composite Airframe Structures

DESCRIPTION: Develop composite airframe structures field repairable design concepts that will minimize logistics requirements considering materials usage, repair equipment, training, and spare-parts inventory. The intent is to improve battle-damage repair capability in the field and demonstrate manageable field-repair concepts. Deficiencies in field-support/inspection equipment,

material-processing capabilities and material-storage facilities will be highlighted. Phase I will include developing repairable-design concepts of various helicopter airframe structures such as skin panel (stiffened skin & sandwich contruction), keel beams, and frames. Phase II will include fabricating representative specimens and demonstrating repair capability using composite materials in the field. Storage-capability solutions will be strongly emphasized.

A89-008

TITLE: Mach-Scale Remote Control Rotorcraft Technology

DESCRIPTION: Scale model radio-controlled rotorcraft represent existing technology. Such rotorcraft currently do not scale the rotor system so that the system stability can be matched to the operator response capability. Recent advances in control technology make it possible to design rotorcraft models at 1/5 scale with an aeroelastically- and aerodynamically-scaled rotor operating at the correct Mach number. The long-range objective is to develop a 1/5-scale model rotorcraft system that can accept model rotors from the wind tunnel for assessment of maneuvering capability and signature characteristics. The objective of Phase I is to provide a detailed preliminary design for the mechanics, power, and control of a 1/5-scale rotorcraft representing a four-bladed operational or conceptual helicopter in the Army fleet such as BLACK HAWK, Apache, or even the LHX. Designs shall be based on model rotor wind tunnel evaluations published by NASA and Army. The objective of Phase II is to manufacture such a scale model for wind tunnel performance and stability testing on a fixed sting. A complete free-flight evaluation is not envisioned.

A89-009

TITLE: Innovative Rotor High Lift Concepts for Helicopter Super Maneuverability

DESCRIPTION: An air-to-air combat scenario for helicopters has been recently introduced into the Army doctrine. The helicopter must therefore achieve an even higher measure of maneuverability and agility in the future. A major limitation affecting both high-speed flight and air-to-air combat is the loss of thrust due to rotor stall. This stall usually occurs on the retreating side of the rotor disc and at high blade angle of attack. Conventional helicopters can pull no more than 2.5 g's during a maneuver, and this is equivalent to an average lift coefficient of 0.75 over the rotor disc. To achieve a 5-g turn would therefore require an average lift coefficient of 1.5, which is not an unrealistic number provided some type of auxiliary device can be used. While many concepts may appear to have merit, the task of actually implementing any active device on a rotor blade will be especially challenging to the designer. For example, centrifugal forces will have to be an important consideration for a mechanical standpoint. Furthermore, if the candidate device were to be a slatted airfoil, the slat would have to be retractable to satisfy the low drag rise requirement on the advancing side during high speed flight. Innovative ideas are therefore solicited for achieving a high life, stall-free rotor which will in turn enhance the maneuverability and agility of future Army helicopters. In phase I, the contractor should examine various approaches and define the advantages of a particular concept as it applies to the helicopter rotor. In phase II, the contractor should construct and demonstrate a working model.

A89-010

TITLE: Smooth, Erosion Resistant Coatings for Organic Matrix Composites

OBJECTIVE: Erosion Resistant Coatings for Organic Matrix Composites for use in Compressor Section of Future Gas Turbine Engines.

DESCRIPTION: Work performed shall include development and verification of smooth, erosion resistant coatings on flat coupons of carbon-carbon or other organic matrix composites for potential application in inlet and compressor components of future gas turbine engines. Coating system shall be optimized and used to coat a sufficient number of coupons to verify good adherence to the substrate, smoothness of coating, sufficient retainment of mechanical properties of the base material, and sufficient hardness to withstand impact of sand particles experienced in gas turbine engines. Phase II work will entail further development and testing of coating systems that show promise from the results of Phase I.

A89-011

TITLE: Updating Current Electro-Magnetic Interference/Electromagnetic Compatibility (EMI/EMC) Test Methods and Equipment

OBJECTIVE: Develop appropriate EMI/EMC test equipment used for qualification of Army aircraft and aircraft components.

DESCRIPTION: Test methods and equipment that are currently in use for the purpose of testing Army aircraft and aircraft components have been in existence for many years. Since these methods and equipment were developed, many advances have been made in the theories pertaining to electromagnetic compatibility/interference as well as in the related technology. Phase I of this project would be to analyze the test methods and equipment currently being used with respect to current applicable theory and technology to determine if these methods and equipment need to be changed. This would include the methods and equipment used for qualification of individual components and systems as well as for the qualification of the entire aircraft. Phase II would be to develop new, cost-effective methods and to propose, develop or locate new equipment to perform this testing. This would include detailed test methods that include pretest and post-test analysis methods, lists of recommended equipment and the types of facilities where the testing should be performed.

A89-012

TITLE: Superplastic Forming and Diffusion Bonding of Cylindrical Casings

OBJECTIVE: Apply Superplastic Forming and Diffusion Bonding (SPF/DB) technology in the manufacture of static cylindrical components for gas turbine engines.

DESCRIPTION: The work to be performed shall include development of Superplastic Forming and Diffusion Bonding (SPF/DB) technology to apply to Army engine cylindrical static component designs such as compressor casings, combustor casings, or IPS housings. The Contractor shall propose the cylindrical component and engines that can best demonstrate the advantages of the SPF/DB process. A review of the geometric, mechanical, and material design considerations shall

be performed, and processing goals established for the chosen cylindrical component in order to apply SPF/DB technology in the most effective manner while maintaining or exceeding structural integrity. Phase II of the program will demonstrate and document viable manufacturing techniques including structural testing of the chosen engine component.

A89-013

TITLE: Interactive Exterior Helicopter Coating for Enhanced Ballistic Tolerance

DESCRIPTION: A basic approach to ballistic protection is to increase the frontal area of the threat projectile. Increased frontal area is typically achieved by tipping and/or deformation. The objective of this effort would be an exterior coating (paint) that should adhere to the threat projectile. By depositing on the projectile the likelihood of tipping would increase along with increased frontal area. The anticipated improved ballistic protection level is relatively small. The proposed coating should be an integral portion of an overall aircraft paint scheme. The coating should be compatible with the other constituents in the paint and have no significant impact on overall weight added due to aircraft painting. The program objective would be a ballistically interactive coating which could increase aircraft skin hardness by 5%, with no weight increase. Interaction would include coating deposition on the projectile and the corresponding increase in projectile frontal areas and tipping.

A89-014

TITLE: Model for Determining Effectiveness of Rockets with Multiple Kinetic Penetrators

OBJECTIVE: Develop models to describe terminal effects of multiple kinetic penetrators.

DESCRIPTION: The potential application of rockets with multiple kinetic penetrators (MKP) as a point fire air-to-air weapon generates a need for the development of realistic MKP rocket modeling and methodology capable of accurately determining the terminal effect of MKP's in an aerial combat engagement. Current rocket models represent rocket time of flight and trajectory; however, few if any have the flexibility or capability to accurately model the unique physical and statistical characteristics of an ejected cloud or clouds of kinetic energy penetrators as well as their terminal effects on selected aerial targets. In order to obtain a better understanding of this new kill mechanism, a concentrated effort to develop models and associated methodology capable of addressing this new weapons concept is warranted.

A89-015

TITLE: Unique Gas Turbine Combustor Aerodynamics

OBJECTIVE: Develop unique gas turbine combustor aerodynamics for future application to helicopters and build and test combustor visualization rig and/or fuel-insertion test rig.

DESCRIPTION: Unique concepts need to be explored for gas turbine combustor technology. Fuel mixing with the air in the combustors primary zone is a major problem, but has the potential for great benefits, which could result in smaller sizes, greater durability, wide range of multifuel capability, and lower fuel consumption. The feasibility of some innovative concepts could be determined by three-dimensional computer modeling and some very simple hardware such as a

water visualization rig. The fuel-mixing problem could include unique fuel nozzle or any fuel insertion system. Wall-cooling techniques shall be considered as a trade-off between efficiency and size of combustor. Additionally, high velocity, but stable combustion should be considered to alleviate diffuser pressure loss. Phase II objectives are to build and test a combustor visualization rig and/or a fuel-insertion test rig.

A89-016

TITLE: Automated Fiber-Reinforced Thermoplastic Fiber Placement

DESCRIPTION: Helicopter primary airframe structures must be lightweight, durable, and damage tolerant to meet mission requirements of future aircraft systems. Thermoplastic composite materials offer an order-of-magnitude improved toughness over their thermoset counterparts making thermoplastics very attractive for use in tailboom designs. These advanced materials in concert with design concepts to relieve the blast/overpressure caused by larger round ballistic impacts will give the helicopter increased ballistic tolerance for a minimum weight and cost. Hot Head Fiber/Tape Laying technology has matured to the point that a tailcone section can be fabricated and tested to demonstrate improved ballistic tolerance and moderate production rates to support future notional systems. Phase I will involve evaluating commercially available tows and tapes, material allowable development, and determining optimum hot head pressure/temperature parameters on a structural element level. Phase II will involve designing, fabricating, and ballistic testing of two or more tailboom section designs.

A89-017

TITLE: Rotor Performance Prediction Capability Using Advanced Aerodynamic Methods

DESCRIPTION: The current level of ability to predict helicopter rotor loads and performance is poor and new analyses (and their implementation in a comprehensive user-oriented code) are required. The specific areas that require improvement are the prediction of rotor wakes on advancing rotors and the prediction of the compressible aerodynamic response to the wake-induced inflow. Current wake-prediction methods use integral aerodynamic methods to predict the wake-induced inflow on a rotor and usually model (rather than actually predict) the wake. Current loads data indicate that these models are inaccurate. A requirement exists, therefore, for a wake-prediction method that does correlate with measured loading and preferably that does not rely on empirical wake information. All prediction methods (including integral and CFD methods) will be considered. This wake subsequently produces an azimuthally varying inflow environment in which a rotor must operate. The subsequent response of the rotor to this inflow is strongly Mach-number dependent. Therefore, a requirement also exists for an ability to predict the transonic, unsteady, three-dimensional local flow on the rotor. Methods for including viscous corrections to this local flow are desirable. An especially important feature would bethe integration of the various aerodynamic flow methods. That is, the wake and/or aerodynamic response methods should be integrated to a standard comprehensive rotor analysis code as well as to each other (if both are proposed).

A89-018

TITLE: Fire Retardant Coatings for Aramid Fibers

DESCRIPTION: As strength increases and density decreases, the application of the new high strength (aramid like) fibers in helicopters will increase markedly. Because of the state-of-the-art nature of the fiber application, some of the secondary materials considered are being ignored. That is, issues such as compressive modulus, fiber/adhesive wetting, fracture toughness, and lay-up are being optimized for primary and secondary aircraft application. This research program would include all aircraft fiber applications, but would have as a primary objective application without resin systems. These "soft" fiber applications include cargo and personal webbing, netting, covers, bags and curtains. Primary issues of the program will be coatings or treatment of fibers to: (1) improve flash point, (2) self-extinguish, and (3) minimization of hazardous gas generation. Since these fibers are to be used in helicopters, the treatment must resist environmental deterioration or be easily renewable. It would also be desirable for the treatment to be usable for existing fibers.

A89-019

TITLE: Integrated Composite Flow Casting

OBJECTIVE: Develop near net shape fiber reinforced component fabrication by hot squeeze casting.

DESCRIPTION: This candidate program involves the evaluation of squeeze casting as an alternative to more traditional fabrication approaches for fabrication of fiber-reinforced airframe/engine components. Any candidate program should involve the feasibility evaluation as well as fabrication and mechanical evaluation of generic test articles. Primary emphasis should be placed on fabrication of reinforced metal matrix composite components. Fabrication to near net shape or net shape is desired. Phase II effort would involve fabrication of a full-scale component using the proposed process.

A89-020

TITLE: Direct Electric Tail Rotor Integrated Drive (DETRID) System for Helicopters

OBJECTIVE: Develop an innovative electric tail rotor application for helicopters in which a tail rotor blade acts as core of an electric motor, providing the necessary antitorque requirement.

DESCRIPTION: Phase I work performed will determine the feasibility and merits/penalties of integrating a helicopter tail rotor into an electric variable speed motor. The tail rotor will comprise the electric motor core. Rare-Earth (RE) magnets will be mounted on the blade tips. Around the rotor blade tips will be a circumferential ring of commutated field coils. Controls and switching logic/electronics will also be investigated. The total DETRID system should operate off that voltage found to be most efficient for the motor. Continuous max torque will be 120 ft/lbs. Blade tip max continuous rate of rotation will be 1,140 RPM. Reaction time for RPM speed changes will be 3-5 seconds. The tail rotor blades will be variable pitch. A variable pitch capability will be designed into the DETRID configuration. Tail rotor diameter will be four feet. Phase II would involve detailed design, fabrication, and bench-type testing for the DETRID configuration.

A89-021

TITLE: Airbag Crash-Protection Concepts for Single Cockpit Helicopters

OBJECTIVE: Develop a preliminary system design with limited testing of critical components.

DESCRIPTION: Cockpits for Army attack helicopters are becoming more confined as cross-section is reduced and more mission equipment is required adjacent to the pilot's surroundings. This cramped cockpit of the future will, therefore, be replete with many head and limb strike hazards in the event of a severe but survivable crash impact. The feasibility of a self-deploying automative-type airbag, filling the cockpit forward of the pilot, increases as cockpit volume decreases in future designs. The objective of this program is to determine the feasibility of such a system considering the many design questions such as the number and location of airbags, crash sensor design, location and sensitivity, gas generator types and inflation times, system weight, and cost.

A89-022

TITLE: Crashworthy Crewseat Designs Having a 20-Degree Seat Back Angle

DESCRIPTION: Today's Army cockpits almost universally use pilot/copilot seats having afixed 13-degree seat back tangent line (reclined 13-degrees from vertical). Future cockpits are projected to require a more reclined pilot/copilot seating position due to reduced frontal area requirements and minimizing windshield area. The design implications and human tolerance considerations of crashworthy (stroking) seats having seat back angles at 20-degrees or more are unknown. Potential seat designs and how the seat-occupant will function in a severe but survivable crash need to be explored. Potential hardware designs need to be defined along with their weight and cost implications.

LABCOM—ARMY RESEARCH OFFICE

A89-023

TITLE: Optimum Imagers For Image Processing

OBJECTIVE: To perform research on the interdependency between the image-detection process and image processing to optimize their combined performance for target acquisition.

DESCRIPTION: Much research is being performed to develop image-processing algorithms and the associated signal-processing hardware to provide reliable, real-time detection and recognition of objects. Most approaches, however, assume a standard rectangular array of image detector elements (pixels), either scanned or from a focal plane array. This process constitutes a sampling and quantization of the real-world analog image field. In this topic, research is sought to investigate the dependence of the performance of the image-processing algorithms on the image-detection process. The goal of this research is to identify the properties of the detection process that affect the accuracy and reliability of the image processing algorithms, to find the functional relationship between image detection and processing, and to use these relationships to define rules for optimization of the combined process. For example, hexagonal sampling of images has been shown

to improve processing performance. The results of this research will be applicable to reducing false alarms and to improving the accuracy and reliability of target detection, classification, recognition, and identification. Original and innovative ideas for image detection and processing that significantly improve automatic target acquisition performance may result from this research.

LABCOM–ATMOSPHERIC SCIENCES LABORATORY

A89-024

TITLE: Ultraviolet Light Detection and Ranging (LIDAR) as a Remote Sensor

OBJECTIVE: Develop the capability for standoff detection of airborne toxins for Army aviation.

DESCRIPTION: An ultraviolet lidar system can provide information about the fluorescent signature (fluorescence spectrum and decay time) of a particular target material. This information can aid in identifying the material. The intervening atmosphere, background materials, and mixed compositions of targets make the actual return signal from a ultraviolet LIDAR a complex mixture of spectra. Decay time determinations from LIDAR data are further complicated because all fluorescent signals do not emanate from the same point
in space. There is a need for development of methods of recognizing the signature of target materials in the presence of competing signatures in a LIDAR return. Phase II efforts shall complete development of a demonstration operational UV LIDAR.

LABCOM–BALLISTIC RESEARCH LABORATORY

A89-025

TITLE: Interaction Of Shaped-Charge Devices With Electromagnetic Fields

DESCRIPTION: The application of electromagnetic effects to shaped-charge design has the potential to provide new ways for modifying and enhancing device functioning, jet characteristics, and the interaction of jets with conventional, special, and electromagnetic armor. Although the magnetic fields needed to produce significant effects are large, such fields are accessible for laboratory work. We are interested in proposals on high magnetic field confinement and entrainment in shaped charges during device functioning, and on shaped charge jet interaction effects with magnetic fields. Computer modeling of MHD effects is inherently more complex than conventional hydrocode calculations for shaped-charge configurations. As a consequence, such studies are expected to be expensive, time consuming, and of uncertain reliability. For this reason, we expect to emphasize experimental studies in our program.

LABCOM–ELECTRONIC TECHNOLOGY AND DEVICES LABORATORY

A89-026

TITLE: High-Temperature Superconductivity

OBJECTIVE: To identify the possible usees for, as well as the potential limitations of, high-temperature superconductors in high-impact Army technology areas.DESCRIPTION: The

basic microscopic theory of Bardeen, Cooper and Schrieffer is used to estimate the characteristics of high-temperature superconductors—the critical distances over which the superconductivity occurs are quite small (~ 20 angstroms), and the critical magnetic fields needed to destroy the superconductivity have extreme type-II values, with lower critical fields of less than 1 kg and upper critical fields of over 150 kg. The magnitude of the estimated characteristics has led us to identify the possible use as well as the potential limitations of high-temperature superconductors in high-impact Army technology areas. Formulations and speculations of artificially created semiconductor structures that might manifest high-temperature superconductivity are of particular interest.

LABCOM—HARRY DIAMOND LABORATORIES

A89-027

TITLE: Dual-Polarization 95-GHz Planar Antenna

DESCRIPTION: A compact 95-GHz antenna is required for development of a millimeter wave standoff fuze for self-contained munitions. Packaging constraints impose severe limitations on the design of both the millimeter wave hardware and the signal-processing elements that can be built into the fuze. Millimeter wave antennas for 95 GHz that are currently available require a considerable amount of space to achieve the type of operation that is required. A reduction in the antenna size would allow more space for other parts of the system and an overall improvement in performance. A millimeter wave fuze design concept currently under investigation includes an antenna for circularly polarized radiation that has characteristics equivalent to that of a quality paraboloidal-type antenna. Compact antennas such as microstrip planar arrays and slotted waveguide arrays have been considered, but improvements in design or in fabrication techniques are needed in order for either of these types of antennas to meet other performance requirements. Proposals that identify methods for overcoming the known deficiencies of these types of antennas or for investigating new compact 95-GHz antenna designs are solicited. Phase I of SBIR program will consist of an investigation of a specific type of circularly polarized radiation. The antenna shall be able to receive simultaneously both senses of circularly polarized radiation, and it shall have an aperture of 15 cm or less in diameter and 3 cm or less in length. The investigation will include analyses and/or experiments that result in a preliminary design and an estimate of how well the proposed antenna will achieve performance goals of 41-dBi gain, 26-mrad 3-dB beamwidth, -18-dB sidelobes, 50 percent net efficiency, 30-dB cross polarization isolation, and 1-GHz bandwidth. Since ruggedness and fabrication cost will be of importance in an ultimate application, comments on these items also should be made in the proposal and at the conclusion of the first phase of the investigation. The second phase shall consist of the fabrication and test of a complete antenna that demonstrates the ability to meet the above performance goals.

LABCOM–HUMAN ENGINEERING LABORATORY

A89-028

TITLE: Effect of Speech Intelligibility on Performance: Testing in Operational Settings

DESCRIPTION: During the summer of 1987, the Acoustics Branch of the Human Engineering Laboratory began a research program to study the effect of speech intelligibility on soldier performance. The first study was conducted at the Fort Knox Coft tank gunnery training facility in February 1988. This research program is designed to produce measures of the effects of intelligibility on soldier performance. The intitial work is being conducted in simulators to provide the experimental control necessary to predict this intelligibility-performance relationship. Subsequent research would be conducted with operational units in the field. Various possibilities for extension of this research are available. One such posibility in the Infantry is described below:

Infantry Task. Infantry manuevers can be broadly classified into three area: attack, defense, and hostage. The following research is described for two platoons of 11 soldiers opposing each other in a hostage situation. Similar research can be designed for attack and for defense manuevers; here the hostage situation is used as an illustration.

Scenario. Whatever scenario is used must be communication- and strategy-intensive to allow us to measure the effects of degrading intelligibility. The hostage situation has these characteristics. The participants are only told the ground rules going in. They do not know the details of the rescue plan. These must be communicated as the progress of the rescue unfolds. A strategy-intensive plan is necessary disrupting communication of the overall success of the plan (the strategy).

Performance Measure. The measures of effectiveness are part-task and whole-task measures. Part-task measures are specific check points in the scenario. (Terrorist appears. How long does it take to kill him?) Whole-task measures are survivability and success of the mission. Performance measures are incorrect actions (killing a friendly), correct actions (killing a terrorist), correct strategy (hold fire until I give the signal), speed of response, rating of difficulty (SWAT), and debriefing evaluation of communication intelligibility.

Although some tasks may be more difficult due to visibility or motor-skill demands, within a scenario communication tasks should maintain a consistent level of intelligibility. Enough scenarios and variations on these must be created to allow for appraisal in repeated measures of design.

LABCOM–MATERIALS TECHNOLOGY LABORATORY

A89-029

TITLE: Joining of Composite Materials and the Nondestructive Evaluation/ Characterization of the Resultant Joints

OBJECTIVE: Develop techniques to join advanced metal-matrix and organic-matrix composites materials and validate their structural integrity/reliability via nondestructive evaluation techniques.

DESCRIPTION: Develop innovative techniques to join advanced metal-matrix and organic-matrix (thermoplastic) composite materials. The joining methods could include the use of heterogeneous

bonding agents such as adhesives and brazes, or autogeneous techniques such as fusion and solid material flow. It must be shown that any joining technique selected does not significantly degrade the bulk properties of either of the composite materials being joined. Validate the structural integrity/reliability of these joining techniques via nondestructive evaluation/characterization methods to assess the interfacial, structural, and mechanical properties of the joints.

LABCOM—VULNERABILITY ASSESSMENT LABORATORY

A89-030

TITLE: Air Defense and Space Systems Electronic Warfare (EW) Vulnerability

DESCRIPTION: Technological advances to support the US Army EW vulnerability assessment (EWVA) program for air defense and space systems. The US Army EWVA program for air defense and space systems has been established to determine the performance of systems or system concepts in hostile EW environments and to develop and recommend electronic counter-countermeasures (ECCM) to preserve system performance in these environments. Technological advances are needed in active and passive electronic countermeasures (ECM), ECCM, ground-based, and laboratory instrumentation and techniques, and analytical methods and techniques. These areas involve all regions of the electromagnetic (EM) spectrum. To advance ECM technology, as applied to air defense and space systems, there are requirements to address methods of active signal generation, cooperative CMs, and passive SMs such as chaff and obscurants. In the areas of ECCM, there are requirements to perform ground-based measurements of parameters of airborne CMs such as responsive ECM, cooperative CM, and cross section or density of passive SM techniques. There are significant shortfalls in the technology supporting analysis of air defense and space systems. Work needs to be done in the development of hardware and software models of terrain clutter, chaff or obscurants, and atmospheric clutter. Another area of importance and interest is the use of fractal geometry for simulation, graphics application, and image decoding and reconstruction.

TROSCOM—BELVOIR RDE CENTER

A89-031

TITLE: Development of Ultrasonic Inspection Method for Heavy-Section Organic Composites

DESCRIPTION: The bottom chord for the Heavy Assault Bridge (HAB) has been designed using a graphite/glass/epoxy composite system. Each bridge uses 12 chords as critical structural support components. A chord is approximately 2.5 in. thick by 30 feet long, with thickness ranging from 1.25 to 3.25 in. The chords are produced by hand layup techniques, and have as many as 600 layers of fibers in a cross section. The ratio of 0 degree graphite/90 degree graphite/ 45 degree pre-impregnated glass cloth layers varies along the length of the chord in order to take advantage of preferential reinforcement properties. The design of the chord also includes bolt holes, lined with steel brushing, through the thickness at various points along the chord length.

Since the chords are considered critical components of the HAB, a nondestructive testing method is needed to inspect the chords for discontinuities that may be detrimental to their in-service use.

Preliminary investigations indicate that some form of ultrasonic inspection would be appropriate for this heavy sectioned composite. This program will concentrate on developing an ultrasonic technique that will be capable of inspecting a full- size chord for discontinuities, and potentially to differentiate between types of fibers (graphite, glass). The equipment and procedures should be applicable to the environments of both production (quality control) and depot (damage assessment).

Phase I will choose the ultrasonic method to be used and prove, through testing, that the method is applicable to the chord involved. In Phase II, the procedure will be refined, and the sensitivity of the method will be determined for specific discontinuities at the applicable thicknesses for the chord. The procedure developed would then be used in quality control of chords to be procured in future contracts.

TROSCOM–NATICK RD&E CENTER

A89-032

TITLE: Improved Polymers for Adhesives for Bonding Selected Elastomers

DESCRIPTION: Butyl rubber is resistant to traditional chemical and mechanical bonding. Some types of adhesives such as selected neoprenes provide a degree of bonding butyl, but improvements are desired. Numerous butyl rubber articles and butuyl coated fabric items are in use and many of these must be cemented together either in production or during repair of damage. It is desirable for greater durability to obtain adhesion stronger than the rubber itself or stronger than the bond between the rubber coating and fabric substrate.

Hypalon (chlorosulfonated polyethylene) polymer is difficult to bond to itself and to other materials. In specfic applications, we are dealing with Hypalon coated fabrics to which other materials must be bonded to fabricate an item. For example, one side of a fabric may be coated with Hypalon and the other with another polymer. The Hypalon must be bondable both to itself and to the other polymer in this case.

Similarly, it is sometimes required to bond butyl rubber to polar rubbers such as polyepichlorohydrin, a satisfactory adhesive for this purpose has yet to be found.

Many adhesives have been made and tried using commercially available polymers but none have proven entirely satisfactory. It is desired to develop new polymers for the above applications. Adhesives made from these can be either solvent based or two-part curable adhesives or for some applications heat-activated adhesives.

MISSILE COMMAND

A89-033

TITLE: Improvement of Test Instrumentation for Filament-Wound Structures

DESCRIPTION: Filament-wound composite structures are more difficult to instrument than typical autoclave-cured structures due to the inherent rough exterior surface and the irregular surface at

the fiber crossovers. Many tests are redone due to poor adherence to the rough surfaces and false readings from the crossovers. There is a need for research to improve the test instrumentation of filament-wound structures.

A89-034

TITLE: Antenna Cross-Coupling in a Damped Resonant Cavity

OBJECTIVE: Derive antenna configurations and associated design parameters that meet specific requirements.

DESCRIPTION: The need exists to investigate the antenna configuration for an RF anechoic chamber that can simulate a controllable, free space RF environment at VHF frequencies and in which the internal dimensions of the chamber are limited in width and height to between one and two wavelengths. Specific requriements are—

a. Dual horizontal and vertical polarization.

b. Capable of presenting a plane wavefront with controllable orientation angle in three demensions at a particular receiver location in the chamber.

c. Minimum mutual cross-coupling such that phase and amplitude of the input signals to each antenna to yield the desired plane wavefront angle and signal level at the receiver location can be readily generated under digital computer control over as wide a range of wavefront orientation angles and signal levels as possible.

A89-035

TITLE: Automatic Taget Model Degradation

OBJECTIVE: Support the automatic creation of less detailed but accurate target models for hardware-in-the-loop flight simulations.

DESCRIPTION: Innovative techniques are needed to degrade the resolution of an infrared target model description to any level of detail. These techniques must consider the computational time necessary to degrade the image. This procedure must be able to be implemented on a large-scale engineering workstation. More specifically, techniques are needed to (1) take a high resolution, three-dimensional, faceted-target model geometry and automatically degrade it to a less-detailed, lower-resolution target model, and (2) take a high-resolution, three-dimensional, faceted, infrared target representation and automatically degrade it to a less-detailed, lower-resolution, infrared representation while maintaining the fidelity of the signature. The techniques developed must be capable of running on UNIX-based engineering workstations such as an IRIS 4D60 Turbo, and must require minimal human intervention in their operation and the creation of output files to be used by other computer programs.

A89-036

TITLE: Data Enhancement Techniques for Measurements Using Bandwidth-Limited Instrumentation

DESCRIPTION: The state-of-the-art of the measurement of fast non-repetitive transients (such as MIL-STD-2169) is usually less than that required for a concise, accurate measurement. Some compromising of the bandwidth of the sensed signal is usually required in order to provide for pre-trigger delay, signal transmission over a long transmission line, etc. The introduction of noise into this situation makes the design of a restoration technique especially difficult. The development of a data-enhancement system for restoration of the bandwidth of signals that is tolerant to noise is required. The system shall be capable of restoring a signal that has been bandwidth degraded by as much as 2:1 in a signal-to-noise environment of 16 dB. This data-enhancement system shall require little or no operator interaction and shall provide an assessment of the quality of the reduced data. This system shall be capable of being operated in the environment of an advanced personal computer.

A89-037

TITLE: Solid State Electronic Gimbal

DESCRIPTION: Methods are needed to dynamically reduce the size (underscan) and control the position of the underscanned area on the photo-conductive surface for solid-state imaging devices such as charge-coupled devices (CCD's) and charge-injection devices (CID's). Variable underscanned areas of up to 4:1 are the goal. For a typical solid state device with a 400 X 400 pixel array format, underscanning the photo conductive surface by a factor of 4:1 implies the utilization of one-fourth of the total sensor area available; one-fourth of the total array would be a 100 X 100 array. Dynamic control of the position (location) of underscanned array implies that the 100 X 100 pixel portion can be located anywhere in the entire 400 X 400 array. Therefore, at any particular time, only one-fourth of the photo conductive surface is being used. Standard video output format must be maintained regardless of underscanning ratios and position of the scanned area. Linear resolution degradation, with respect to degree of underscanning, is recognized. Dynamic positioning control (or new position update) and size control shall be from DC to the TV frame rate. The technique of moving the reduced scanning area over the sensor surface is analagous to the angular motion imparted to a TV sensor mounted on an electro-mechanical gimbal and will be referred to as solid-state electronic gimballing. One practical application is to provide image stabilization electronically rather than with electro-mechanical gimbals.

A89-038

TITLE: Concepts for Spatially Encoding Millimeter Wave Beam

DESCRIPTION: Innovative concepts are needed for spatially encoding millimeter wave beams for beamrider missile guidance applications. A rearward-looking receiver on the missile senses its position in the beam from the spatial coding, and provides corrective commands to the missile to cause it to fly down the center of the beam. The concept should be lightweight, small in size, and economical to produce. The construction of a prototype beam projector and receiver and validation of the combined performance is an essential part of the Phase I effort. Millimeter beamrider

guidance has potential for direct fire, antiarmor applications, and as the mid-course phase of a concept that features handover to a homing seeker for the terminal phase. The concept developed under this program should be applicable to both guidance concepts. The long-range objective of this program would be a brassboard demonstration of the beam-encoding concept that includes the receiver.

A89-039

TITLE: Ceramic Components for Turbojets

DESCRIPTION: The performance of small gas turbine engines can be significantly improved by utilizing a ceramic turbine and bearing because of the higher operating temperature such components would allow. Ceramic turbines have already been introduced in turbochargers and it would be extremely worthwhile to exploit this available component in a small tactical turbojet. Innovative research is required to integrate a ceramic turbine and bearing into a tactical turbojet engine. Feasibility investigations must include determining the operating temperature limit and operating life of such components in the context of a small, short duration tactical turbojet engine.

A89-040

TITLE: Correlation of Insensitive Munitions Tests to Card Gap Values

DESCRIPTION: Research is needed to establish the correlation between card gap values and insensitive munitions tests for various missile propellant formulations. Results from shock sensitivity and bullet impact testing will be compared with the corresponding card gap values for the propellant formulation in question. Comparison of such data provided to the investigator will then be used to determine the relationship of shock and bullet impact sensitivity to corresponding card gap values. This correlation could then be used to predict the response to such insensitive-munitions testing of a propellant formulation based on its known card gap value.

A89-041

TITLE: Tandem Warhead Technology

OBJECTIVE: Establish a theory of tandem warhead behavior by establishing design algorithms and testing procedures.

DESCRIPTION: Tactical missiles attacking hard targets, i.e., tanks, bunkers, etc., will rely increasingly on tandem warhead technology. The effectiveness of two or more warheads to defeat advanced armor has been proven in several programs. Valuable information about physics of warhead interaction and its effect on performance has been acquired. The investigative programs have been expensive, and have frequently had detrimental impact on overall program schedules. Critical parameters affecting tandem warhead performance are required so that design and testing can be accomplished more expeditiously. Of special importance is a means of predicting blast-induced interactions and their effects on jet formation and performance. Means of minimizing the detrimental interactions are needed. The effects of separation, jet speed, and time delay on performance should be characterized.

A89-042

TITLE: Non-Destructive Evaluation (NDE) Methods/Technologies Applicable for Nozzles Made of Reinforced Phenolic

DESCRIPTION: There exists a need to determine and prove NDE/Methods/Techniques that analyze reinforced phenolic materials currently being used for nozzles of various systems. This technology is very much needed to determine missile/ rocket and detect cracks, porosity, voids and other anomalies in the nozzles that influence the mechanical properties and therefore, could cause strength variations that may result in nozzle failure. These methods are also needed to determine reasons for poor repeatability of mechanical property data that have been experienced by these materials. This effort would verify and simplify the utility of this most promising non-destructive test methods of phenolics in nozzle applications.

A89-043

TITLE: Development of Physically Low Thickness Radio-Frequency-Absorbing Material

DESCRIPTION: A material for lining the boundaries of an RF anechoic chamber that simulates a free-space environment at VHF/UHF frequencies is required to be designed and developed. The material is required to have a physically small thickness relative to the wavelength of the lowest RF frequency used in the chamber.

A89-044

TITLE: Dynamic Stability of Flexible Missiles

DESCRIPTION: Slender spinning missiles are suspected to be sensitive to dynamic coupling between the spin and the transverse axes. This phenomenon could be triggered by strain energy stored within the missile body due to launch conditions and/or structural damping. Spinning satellites with nutation dampers have been studied in detail. The same phenomenon will probably exist for slender flexible spinning missiles flying within the atmosphere. Aerodynamics will affect their behavior until burnout. Innovative research is needed to determine the magnitude and possible effect of this coupling on the behavior of missile trajectories. Sudden and momentary transfer of rotational energy from spin about the minimum axis of inertia to some other configuration could explain some observed flight abnormalities. The follow-on phase involves improving the range and accuracy of rockets and missiles. The goal would be to accurately launch and fly to line-of-sight targets at hypervelocities to extended ranges. Missiles with high length-to-diameters will be required for low drag.

A89-045

TITLE: Large Size Indium Gallium Arsenide (InGaAs) Protodetectors

DESCRIPTION: Indium gallium arsenide (InGaAs) photodetectors are becoming quite important in receivers for fiber optics communications systems and eyesafe laser rangefinders in the 1.3 to 2.1 micrometer spectral region. At present, the detectors are small (1-2 mm diameter or less), and cannot be used in laser seekers or trackers which have a large field-of-view and thus require large detectors (greater than 1 cm diameter). Quadrant detector configurations are needed for many of

these applications. Research is required to develop the large-area detectors that must have high sensitivity to pulsed laser radiation.

TANK-AUTOMOTIVE COMMAND

A89-046

TITLE: Large-Area Passive Broadband Laser Filters

OBJECTIVE: Successful fabrication and demonstration of a broadband filter that can be integrated and used with existing unity vision equipment designs.

DESCRIPTION: A need exists for broadband laser filters that operate in the visible region (400-700 nanometers), do not require any external biasing (thermal or electrical) or a focal plane, and can be used over relatively large areas (100 square cm). The filter should normally have a high photopic transmission (50% or greater) and must provide protection against both pulsed and continuous wave (CW) lasers. It is recognized that a combination of approaches may be necessary to meet these goals.

TECOM—WHITE SANDS MISSILE RANGE

A89-047

TITLE: Multispectral Data Processing

DESCRIPTION: Multisensor tracking platforms for instrumentation support of inflight missile and aircraft systems testing are being developed that will have a high-resolution coherent millimeter wave (MMW) radar collocated with visible and infrared imaging sensors. Development of a processing methodology is required that is capable of cooperatively integrating the information available from all three sensors to provide a comprehensive estimate of flight vehicle position, attitude, and event parameters. For example, the attitude information available from visible and infrared sensors might be augmented by the spectral information available in the radar return. (The processing technique that provides the detailed spectral analysis of coherent radar signals has already been developed and is used on a regular basis).

Conversely, the visible and infrared images might better define the range data available from the radar return. Hardware requirements and architectures commensurate with the proposed methodology and expected processing loads need to be identified.

A89-048

TITLE: Digital Focusing

DESCRIPTION: The focusing of optical instruments during optical track is currently done using radar data. Accuracy needed for many missions requires a more precise focusing method. Focusing based upon analysis of real-time video images using special purpose hardware will result in more accurate focus. This hardware could work either in the frequency or time domain. Focusing algorithms must operate at rates high enough to keep video cameras focused while operating at sixty fields per second. Commercially available systolic array architectures, such as the

GAPP chip produced by NCR Corporation, appear to be promising as low-cost hardware engines for solving the focusing problems encountered in tracking high-dynamics targets. The desired objective is to produce a low-cost hardware design that can solve this focusing problem.

TECOM–COMBAT SYSTEMS TEST ACTIVITY

A89-049

TITLE: Heat Flux Sensor for Vulnerability Testing

DESCRIPTION: The US Army performs vulnerability tests on many of its weapon systems. Testing usually involves exposing a fully loaded weapon system to live anti-armor ammunition. The weapon systems under test are loaded with ammunition, fuel, dummies in place of troops, and various instrumentation. During vulnerability testing the dummies inside the test item can be exposed to adverse temperature and heat flux conditions. Temperatures can exceed 2000 degrees Fahrenheit. It is important to measure the conditions each dummy member has been exposed to during a live-fire event. Of particular interest is the heat flux levels necessary to cause second or third degree burns to the human body. An appropriate model for heat flux versus burn to the human body will be selected. A sensor will be developed that can accurately measure the heat flux levels necessary to cause burns to the human body. Calibration equipment will be developed that will allow the user to verify the operation and accuracy of the transducer just prior to testing. The transducer will be small enough to be mounted at one of several locations on a dummy placed inside the weapon system under test. The transducer output will drive at least 200 feet of shielded low impedance cable.

TECOM–YUMA PROVING GROUND

A89-050

TITLE: In-Bore Motion Detection System for Flash X-Ray Trigger

DESCRIPTION: The present, non-contact method for triggering is mounting in the gun barrel pressure transducers that detect the passage of the projectile. This method is not acceptable for thin-wall gun barrels, composite gun barrels, and for in-bore flash X-ray studies. This and the alternative method of using strain gages often do not work when an in-bore malfunction disturbs the normal pressure characteristics. A new non-contact method for triggering is required to meet these applications. The primary application would be for main tank guns but should also be suitable for artillery weapons.

TECOM–ELECTRONIC PROVING GROUND

A89-051

TITLE: Testing Embedded Parallel Processing-Based Systems

OBJECTIVE: Creation of a set prototype software tools for testing embedded systems employing parallel processing technology.

DESCRIPTION: A variety of Government- and industry-funded research initiatives are underway to create, develop, and transfer to production computational environments based on multiple processors operating in parallel to generate levels of computing power beyond what is available in conventional architectures. A number of these environments have already reached the stage of commercial products. The computational models upon which these environments are based differ in terms of granularity of parallelism, degree and methods of coupling processing between processing elements, topologies, and protocols for interprocessor communication. Testing of embedded systems employing these environments is likely to require novel techniques, and these techniques will vary to some degree with the computational model implemented. Moreover, the testing will need to extend into the characteristic of the environment itself to verify a correct implementation of the model employed as the technology will be, for some years to come, immature in comparison with compiler, operating system, and architectural technology of current systems. This task should seek to establish a working taxonomy of computational models, build an extensible tool to aid in identifying and characterizing systems under development in terms of the taxonomy, and build a prototype tool to generate, from a library of proven algorithms, benchmarks for testing model features implemented in the environment to be tested.

TECOM–DUGWAY PROVING GROUND

A89-052

TITLE: Optical Sensing Using a Naturally Illuminated Scene

DESCRIPTION: Current scintillometers utilize a transmitter and receiver to define a optical path; however, crosswinds can be measured using a naturally illuminated scene (i.e., no transmitter). Path-weighting functions can become complex, but the procedure is feasible. A scintillometer of this design has significant military applications for correcting gun azimuth and elevation for optical distortion and crosswind. The objective is the development of a scintillometer that will utilize the naturally illuminated scene.

CECOM–CENTER FOR COMMAND, CONTROL, AND COMMUNICATION

A89-053

TITLE: Artificial Intelligence for Command and Control

OBJECTIVE: The objective of this effort is to design a tactical decision aid for eventual use by an Army commander or staff member.

DESCRIPTION: The decision aid should be designed to significantly enhance military planning as currently practiced in the field or in garrison. The target environment for the decision aid is a testbed that supports extensive Army user interaction within field training or command post exercise. The design must integrate artificial intelligence techniques with other technologies into a system of demonstrable utility to an Army user.

Possible decision aid include (but are not limited to)—

1. A wargaming facility that provides detailed explanations to user questions;
2. A course of action advisor/critic;
3. An integrated geographic information system and terrain analysis system;
4. A site-selection advisor (e.g. signal centers, supply points, headquarters *location*);
5. A force-movement analyzer that advises staff member on movement alternatives and time constraints;
6. A terrain-management tool which assigns both combat and support units to appropriate locations;
7. An obstacle-emplacement advisor for preparing a combat engineer barrier plan;
8. A route-selection/evaluator system for logistics support;
9. A tool that projects fuel consumption rates based on terrain, weather, vehicle types, mission, etc.;
10. A system that intelligently displays and manages tactical graphics for staff planners; and
11. A distributed force-level control system that facilitates cooperative problem solving among dispersed command posts.

The decision aid must be effective, yet easy to use. As an example consider the portrayal of battlefield geometry, which many of the above systems must represent. It consists of—

1. Control measures (e.g. *flight corridors, objectives*, axes of advance, phase lines, prepared positions, main supply routes, lines of communications, bridging sites, and avenues of approach);
2. Key terrain;
3. Barriers and obstacles; and the
4. Communications grid (including indigenous capabilities and electronic warfare network coverage).

A useful decision aid must allow rapid and easy input of battlefield geometry by the user. The system should provide explanations as necessary; but unobtrus'vely support the user's mission. A successful system design will—

1. Describe the user's environment;
2. Identify the specific user needs to be addressed by the system;
3. Specify the functional components of the system and their interrelationship; and
4. Describe the procedural basis of each component to an appropriate level of abstraction.

The first three items listed above should be written in a manner accessible to regular Army personnel for their review and comment. A limited prototype demonstration of the objective system is desirable, but not mandatory.

CECOM—CENTER FOR SOFTWARE ENGINEERING

A89-054

TITLE: Requirements Engineering Technology

DESCRIPTION: The requirements statement for an Army system can be viewed as an architectured product, with an associated life cycle. This leads to the notion of requirements engineering that can be defined as "a systematic approach to the development, transition, evolution and dissolution of requirements for a system." This is a relatively new concept with little or no supporting technology. The purpose of this SBIR topic is to solicit innovative ideas and promising techniques that would be a foundation for, or be an integral part of, requirements engineering.

Phase one products would be reports establishing proof of concept or describing the approach and procedures to be used for the requirements engineering techniques proposed. Phase two products would involve demonstration of techniques, prototype tools, and reports fully describing the techniques and procedures developed and recommendations for incorporating those techniques and procedures into the system life cycle.

CECOM—CENTER FOR EW/RSTA

A89-055

TITLE: N-Feature Electronic Support Measure (ESM) Data Clustering and Matching

DESCRIPTION: Rapid clustering and matching of N-feature ESM sensor data in a high density EW environment is critical to ESM/ECM performance. The availability of multisensor data with intermingled feature parameters offer a good application for clustering and matching algorithms and techniques. High density signal environments are composed of large numbers of signals in time/spectral overlap, not easily separated by the window addressable memory functions currently utilized. The EW objective in this case is to conduct N-feature space clustering and matching for rapid signal separation, identification, and decisions. The solution should address threat system War Reserve Modes (WARM) and agilities, adapt to changing signals and environments, and have the capability of developing and extracting operational templates for optimum tracking and/or prediction in the support of countermeasures or hand-off to hard kill tracking weapons. In these applications it is necessary to reliably isolate a single emitter or system in a complex feature space having closely related neighboring signals and adapt to changing signals and environments.

The Phase I effort will evaluate and analyze innovative processing approaches, techniques, designs, or algorithms which achieve signal separation goals. The concept shall be defined and assessed in comparison to existing methods and systems. The goal of Phase I shall be to define the problem and to demonstrate analytically concept feasibility. The Phase II effort will concentrate on detailed definition of the concept with a demonstration, test, and verification of proof-of-principle.

CECOM—CENTER FOR SIGNALS WARFARE

A89-056

TITLE: Antenna-Amplifier Network Integration

DESCRIPTION: The objective is to develop a modular power antenna-amplifier using field effect transistor (FET) technology to achieve a non-linear active antenna impedance matching network with very high power density non-linear amplifier. The antenna-amplifier is to be the linear transmitter for small jammer, e.g., RPV, expendables, as well as the basis for forming very high power transmitter from a few modules. It must provide good efficiency for maximum emitted power output. It is desired that the distortion products be as low as possible to provide low harmonic content in large transmitters, but must be held to a practical value in order to maintain reasonable efficiency. This work is aimed at simultaneous dramatic improvements in antenna-amplifier power and bandwidth for a given size which will require a substantial improvement over present capability. Highly imaginative and innovative techniques will probably be required, but must be limited to practical approaches usable for military applications such that further development could produce equipment suitable for operation and maintenance by US Army forces in the field.

In jamming systems, requirements for large gains, bandwidths, directivity, and efficiency are often present. When the weight and size of the installation are not of overriding concern, the preferred approach would be to use antennas of sufficient size to ensure that these objectives are met. Such antennas are usually several wavelengths or larger in size, and then typically include conventional dipoles, whips, log periodics, and other types. In many cases, however, such as with small mobile platforms (e.g., jeeps and small RVPS), the available space may be extremely limited. In addition, other limits are sometimes encountered, such as the often critical aerodynamic constraints associated with some RPVS, which do not allow the use of large antennas. "Electrically small" antennas, or antennas that exhibit maximum dimensions less than a half wavelength, are often the only alternative. Unfortunately, electrically small antennas have imposed severe limitations upon the overall efficiencies of these jamming systems, particularly where broadband operation is desired.

PHASE I - The feasibility of an antenna integrated with active amplifier circuitry is to be investigated to achieve significantly improved performance. This would accomplished via design analysis of active circuitry driving the very small radiation resistance directly without the necessity of matching impedances to a common level (normally 50 ohms). The major thrust of this effort is to develop unique approaches to the design of broadband, electrically small antennas, with *improved transmitting* efficiencies, through the use of active circuitry. That is, active circuits are to be used in place of conventional, passive matching networks for improved bandwidth and matching efficiency. In addition to this, the actual antenna structure is to be integrated (attached directly) with the RF amplifier itself so that the two are considered as one entity (with possibilities for improved performance).

PHASE II - The contractor shall design, fabricate, test, and evaluate an interim antenna amplifier of each possible candidate type to demonstrate the achievement of 3- to 300-MHz and 1-30-MHz bandwidths using existing low power FETs. The minimum power output should be 100

watts. This design should also demonstrate achieving high radiated efficiency and distortion and spurious products output requirements.

Using the output of above, the contractor shall design, fabricate, test, and evaluate a high power design of each type using any available and/or experimental high power transistors, or combination of circuit approaches if only low power devices are available. The minimum RF power output in the fundamental frequency should be 250 watts continuous wave (CW) from 3 to 300 MHz and 500 watts, 1 to 30 MHz. This design should show achieving the frequency range and any tuning time, efficiency, distortion, and spurious products and be at the smallest possible physical dimensions achievable, limited only by the thermal hotspot temperatures of the components for CW operation. Each candidate shall be evaluated for attainment of all of the performance, physical, and other requirements. The emphasis shall be on achieving high power density (watts per cubic cm, watts per kg). The amplifier shall demonstrate the feasibility of being air cooled (with the use of fans) when in a stand-alone or two-amplifier configuration for small jammers and being liquid cooled when in multiple BPM amplifier configuration for large standoff jammers.

CECOM—CENTER FOR NIGHT VISION AND ELECTRO-OPTICS

A89-057

TITLE: High-Temperature Superconducting Infrared Sensor and Components

DESCRIPTION: The following class of projects involve applying the results of new high-temperature superconductors to infrared systems:

(1) Bolometric Sensor—This involves using the superconducting transition temperature as the infrared sensor mechanism.

(2) Weak Link Detector—This involves using the weak link properties of the superconductor as an infrared detector.

(3) Thermoelectric Cooler—This involves the use of superconducting elements in the cold stage of the TE cooler to achieve lower temperature.

(4) Superconducting Optical Shutter—This involves using superconducting as an optical switch.

COE—CONSTRUCTION ENGINEERING RESEARCH LABORATORY

A89-058

TITLE: Cognitive Formatting of Electronic Documents

DESCRIPTION: In the future it will be possible to get both an electronic copy and a paper copy of almost any document. To alleviate the classical "precision vs. recall" problem of information retrieval, it would be helpful to embed in the electronic document electronic "flags" that classify the document as to its "cognitive form." Several standards for word processing and for publishing are available, but currently no standards exist for classifying the cognitive aspects of a document's

contents. A classification system needs to be developed that classifies the knowledge contained in a document by several "orthogonal" reference axes. (One would hot e that an orthogonal retrieval approach would increase "recall" without reducing the "precision" of an information retrieval search). The document content classification system should be generic enough to be used in both the Arts and the Sciences, and should allow for sub-sets of more restrictive classifications peculiar to a certain discipline.

A89-059

TITLE: Video Imaging for Building Interior Maintenance Inspections

DESCRIPTION: Facility maintenance inspections are performed periodically for determining facility condition and work needs. Visual inspection procedures are almost exclusively employed. This is a very labor-intensive process and limits the amount of actual inspection that can be performed due to resource techniques be developed that can capture the needed inspection information for building interiors. The information should be captured, digitized, and be tranfered directly into a computerized database.

A89-060

TITLE: Underground Storage Tank Finder

DESCRIPTION: Leaking underground storage tanks (UST) are a major source of groundwater pollution in the United States. There are over a million known UST's and many more unreported abandoned UST's whose exact location is not known. The purpose of this project is to develop a field-portable device to locate abandoned and unreported UST's that are constructed of steel, fiberglass-reinforced plastic, concrete, and other construction materials. The UST locator should strive for low cost as well as simplicity so that it can be used by field personnel.

A89-061

TITLE: Lead Concentration Monitoring and Compliance in Drinking Water Distribution Systems

DESCRIPTION: Recent amendments to the Safe Drinking Water Act (SDWA), applicable to all Army installations, require extensive monitoring for lead concentrations in drinking water at the consumer's tap. If the lead concentration exceeds maximum contaminant level (MCL), the SDWA requires modifications in the treatment process to reduce the lead contamination level. However, there is no specific guidance for treatment technique requirements for control of lead. The objective of this research is to develop a non-intrusive standardized test method for lead control, which does not require utility personnel to enter consumers' homes. The standard test will be designed to optimize treatment technique requirement for Army water utilities to implement, aimed at the minimization of lead leaching from home plumbing, in particular.

COE—ENGINEERING TOPOGRAPHIC LABORATORY

A89-62

TITLE: Controlled Digital Image Data Base

DESCRIPTION: Develop the concept of a controlled multisensor digital image database where the digital image database is to be regarded as a component of a larger database that includes

knowledge bases, factual databases, and a dynamic target database. The dynamic target database pertains to current locations of targets detected in the past as well as predictions of their future locations. The conceptual development must include a discussion on means to rigorously adjust a variety of digital images (EO, SAR, and IR) to a common coordinate frame. The discussion will include existing work on multisensor record registration as well as a discussion on known large-scale least-squares adjustment procedures. The development will consider hardware and software means to store images and to access sub-images with respect to the proposed image database theory. Two primary uses of the digital image database will be to provide a background for database viewing and to provide a controlled database for registering remotely collected digital images for the purpose of target location and analysis. These functions must be discussed in the development as well as other functions. For example, since the image set is controlled it will be possible to produce information on a suspected target from several spectral viewpoints. Comparisons will be made with factual databases (terrain databases and digital map data) with respect to the functions. For example, when weather data and environmental conditions are fused with terrain data to provide statements about the surface condition of the battlefield how can the generated database best be viewed by the user.

A89-063

TITLE: Development of Digital Terrain Feature Models for Automated Feature Extraction

DESCRIPTION: Object recognition and identification in industrial computer vision deal with relatively simple and predictable objects that lend themselves easily to image modeling. Image models of objects may be represented symbolically and used in the recognition and identification process. Examples are automated part inspections or industrial robot controls. The pixel structures of terrain features on digital imagery are not simple and show a large degree of variation. Image modeling of a digital terrain feature requires in depth analysis of a sufficiently large number of samples for each particular terrain feature. The development of digital terrain feature models must include but not be limited to— quantitative measurements of the digitized spatial gray-tone distribution of the feature; definition, identification and measurement of image feature primitives and descriptors; determination of feature-to-background characteristics; investigation of the effects of the geographic location on the feature characteristic; evaluation and utilization of image interpretation rules and logic; identification of image processing algorithms and computer vision techniques; approach and strategy required for effective and efficient automated feature extraction. The feasibility of digital terrain feature model development shall be demonstrated using the following feature classes— roads, intersections, and forests. Digitized samples from aerial photography of these two feature classes may be made available on request for the Phase I effort. More feature classes may be added for Phase II.

COE—WATERWAYS EXPERIMENT STATION

A89-064

TITLE: Passive Airblast Attenuation Valves for Conventional Weapons

DESCRIPTION: Design several types of passive airblast valves to replace active blast valves currently being used. Recent data from full-scale tests using general-purpose bombs indicate that

active valves are no more efficient at reducing blast pressure than an equal airflow constriction that does not close. The potential savings using low-cost, low-maintenance, passive valves are considerable. The passive valves should be about 2 feet square by about 2 feet deep to fit into existing configurations. They should reduce peak pressure about two orders of magnitude, i.e., from 500- to 1,000-psi input peak pressure to about 5- to 10-psi output peak pressure. Note that data from actual tests show that the empty 2 feet square hole will reduce peak pressure from about 400 psi to about 15 psi. The passive valve designs should not cause more resistance to normal airflow than the existing active valves. Selected designs will be constructed and subjected to actual thrust airblast environments.

COE–COLD REGIONS EXPERIMENT STATION

A89-065

TITLE: Equipment for Measuring the Mass Concentration of Solid Particles Suspended in Air

DESCRIPTION: Equipment is required to measure and record the mass concentration of solid particles suspended in air. When the air is moving (as in windy weather or in a wind tunnel), the equipment must also measure and record the mass flow rate (i.e., concentration times velocity). This equipment must be suitable for measuring profiles across a turbulent boundary layer as for instance the concentration and flux of blowing snow from ground level to a height of about 4 meters, with winds up to 30 meters per second (60 knots). Mass concentration of solids is expected to be in the range from about 0.1 to 500 grams per cubic meter. Mass flux of solids is expected to range from about 0.7 to 8,000 grams per square meter per second. Mean particle size is approximately 0.1 millimeter.

A desirable but not essential second application for this equipment is expected to be a requirement for measurements in a wind tunnel that blows a suspension of very small activated clay particles (with the finest fraction behaving almost like smoke). In general form this equipment would be suitable for measurements of any dust or powder suspensions in air or other gas.

Proposals must include a description of the calibration and validation methods to be used to verify the proper performance of the equipment.

ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A89-066

TITLE: Advanced Technology Applications for Foreign-Language Training and Sustainment

DESCRIPTION: Changes in military doctrine on operational readiness in response to world conditions have resulted in an increased demand for military personnel qualified to communicate in a foreign language. In order to train and maintain a level of proficiency in foreign-language skills adequate to meet this demand, the Army is seeking to capitalize on the strengths of technology, particularly Artificial Intelligence, for producing language-learning and sustainment environments. Effective systems need to be developed to create intelligent, interactive learning within English and

critical foreign languages such as German, Korean, Russian, and Spanish. Effective architectures need to be investigated and synthesized in these environments, using hypertext, multimedia, natural language processing, and large-scale databases and dictionaries. In addition, the technologies of intelligent tutoring need to be exploited to provide adaptive delivery environments using student modeling, error diagnosis, and effective knowledge-representation techniques.

An effective environment in English and one foreign language should be the goal of Phase II.

A89-067

TITLE: The Relationships between Experience Factors and Rapid Tactical Decision Making

DESCRIPTION: The objective of Phase I will be to develop and detail a testable theory of the relationship between various military experience factors such as knowledge of weapon and support systems, of enemy capabilities and doctrine, of tactical principles, of military history, etc., plus types of practical experience in applying these and the ability to make reasonable tactical decisions within the time and information constraints imposed by the modern battlefield. This will be a theory of military tactical decision-making expertise with hypotheses that can be tested either in the laboratory, the classroom, or in field exercises. The products of the Phase I effort will be—

- A literature review of causal factors and theories of decision-making expertise in general with emphasis on that literature applicable to military tactical decision making.

- A theory of military tactical decision-making expertise tied to the existing literature and to information gained from tactical decision-making experts. The theory will include concrete, testable hypotheses and a logical plan of research intended to create an empirical evidence base for the theory and demonstrate its application to military training and command and control systems and organization.

Phase II will consist of execution of the research plan developed in Phase I, or that portion of the plan that can be executed within the available resources. The end product of Phase II will be specific recommendations based upon empirical evidence and sound theoretical principles that can be used by the Army to improve tactical decision-making quality and timeliness. These recommendations can concern the training of decision makers, the organization of staffs for decision making, or means of supporting the decision-making process. The products of the Phase II effort will be—

- A technical report of the basis, conduct, and result of each experiment or set of related experiments performed under Phase II. It is estimated that between two and four such reports will be required.

- A final report that summarizes the Phase I and II effort and contains the recommendations mentioned above.

A89-068

TITLE: Techniques for Option Generation in Decision Making

DESCRIPTION: Option generation is a critical part of decision making and any improvement in option generation in military decision making would yield high pay-offs. The basic research literature in decision making contains examples of approaches to stimulate and assist option generation. These approaches should be cataloged, new approaches developed where appropriate, and the best approaches tested for feasibility and payoff. The best candidate approach should then be implemented as an automated decision aid. The objectives of Phase I will be to (1) review and analyze the literature in option generation in decision making; (2) identify or develop two or more candidate aiding approaches or techniques for option generation; (3) experimentally test the candidate techniques; and (4) select one technique for implementation as an automated decision aid. Phase I products include a report documenting the results of the literature review, and a report documenting the experiment testing the candidate aiding techniques and describing the aiding concept that is to be implemented.

The objectives of Phase II will be to (1) design an automated decision aid for course-of-action generation in tactical planning; (2) implement the design in a prototype aid, and (3) evaluate the prototype aid. Phase II products include a prototype decision aid to support option generation in G3 planning and a report documenting the evaluation of the prototype aid.

A89-069

TITLE: Development of Methodology for Assessing the Effectiveness of Command and Control (C2) Functions During User Testing

DESCRIPTION: A wide variety of automated systems used in the command and control process are currently being developed for use by the Army. Examples of such systems include the Extended Position and Location Reporting System (EPLRS), the Maneuver Control System (MCS), and communications systems like the Single Channel Ground and Airborne Radio System (SINCGARS) and Mobile Subscriber Equipment (MSE). In addition, computer technology is being used to develop various training devices that will be used in part to train command groups. A prominent example is Simulation Network (SIMNET).

Such systems must undergo user testing and evaluation before they are accepted by the Army. This is done to demonstrate that systems meet Army needs. Initially, a system undergoes operational testing (OT) to see how adequately it operates in an operational environment, and sometimes the system is also subjected to Force Development Test and Experimentation (FDT&E) in order to determine the best way to employ the system tactically and operationally.

One of the issues frequently addressed during the formal evaluation of a system is the extent to which a given system improves the command and control process. This has traditionally proven to be a rather difficult task to perform, and testers have typically relied on subjective impressions and ratings of commanders and their staff to provide information to address the issue. Objective performance data to address the issue have seldom been collected.

There have been some attempts to develop more objective procedures for evaluating the effectiveness of command and control procedures. Examples include using Army Training and Evaluation Plans (ARTEPs), and the Headquarters Effectiveness Assessment Tool (HEAT). But these methods tend to be cumbersome and very manpower intensive, in addition to being of unknown reliability and validity.

There is thus a need for the development of a method for objectively measuring the effectiveness of command and control functions. The method should be applicable to evaluating (C2) functions at battalion, brigade, and division level during user testing and evaluation. Conservation of manpower on site during testing is important. Utilization of computer technology to collect and process objective performance data is highly recommended.

It should be noted that this problem is similar to evaluating (C2) during training of command groups, and any method developed under this program will likely have applicability to evaluating training programs. The unique focus here, however, is on developing measures of (C2) that can be applied during user testing of systems under field conditions that simulate a combat environment.

The work will be accomplished in two phases. The objectives of Phase I will be to (1) develop objective performance measures that can be used to evaluate the C2 effectiveness of command groups in maneuver battalions, maneuver brigades, and divisions, and (2) develop a plan for validating those measures. The deliverable will be a report that reviews previous work in the area, describes the performance measures developed for this effort, the rationale for their selection and development, and a proposed validation plan.

The objectives of Phase II will be to (1) validate the performance measures during a field test, (2) refine the measures as a result of the validation effort, and (3) revalidate the measures on another field test. The final report will fully describe the performance measures, the validation process, and the methodology for analyzing the measures.

MEDICAL RESEARCH AND DEVELOPMENT COMMAND

A89-070

TITLE: Production of Recombinant Flavivirus Antigens

DESCRIPTION: Recombinant antigens are needed for development of vaccines and diagnostic tests for 4 serotypes of dengue and Japanese encephalitis. Optimal expression systems, methods of purification, and methods of delivery are required.

A89-071

TITLE: Purification of Sub-Unit Vaccine Candidates

DESCRIPTION: Crude cell suspensions or lysate will be purified by appropriate techniques, such as chemical precipitation, centrifugation, column chromatography, and electophoresis so that immunogenic proteins at high specific activity may be used for biochemical and immunological tests as well as immunization of animal.

A89-072

TITLE: Development of a Tri-Enzyme Enzyme-linked Immunosorbent Assays (ELISA) System

DESCRIPTION: Enzyme-linked immunosorbent assays (ELISAs) are used to detect a wide variety of antigens and antibodies, e.g., microorganisms in blood. Most ELISAs are designed to detect only a single antigen even though tests for different antigens in the same sample are required. The development of a tri-enzyme ELISA system would permit the concurrent testing of a single sample for three different antigens, each being identified by the development of a different color in the ELISA plate. Development of this assay requires the identification of three enzyme-substrate systems which: (1) have similar optimum reaction parameters, e.g., pH; (2) develop different colored products with different optimum absorbance wavelengths; and (3) have the required sensitivity. Such a system would have wide applicability and could reduce by as much as 60 percent assay time, required supplies and reagents, and associated costs.

A89-073

TITLE: Biological Assay of Candidate Antiparasitic Drugs

DESCRIPTION: Develop reliable and reproducible biological assays and models for the assessment of antiparasite activity of candidate drugs of diverse chemical classes. Parasitic diseases of importance are malaria, leishmaniasis and schistosmiasis, and the determination and evaluation of parasite drug resistance is a principal concern. Methods should utilize techniques to accurately measure such parameters as exponential parasite growth rates, parasite survival, and the effects of antibiotics or antimetabolites. The acquisition of information about biochemical and molecular mechanisms of drug action and resistance would be a distinct advantage. Where possible, clones of human parasites with known knowndrug susceptibility patterns should be used. The ultimate program objective is the development of new and effective curative and prophylatic antiparisitic disease drugs.

A89-074

TITLE: Synthesis of Potential Antiparasitic Diseases Drugs

DESCRIPTION: The objectives are the design and synthesis of new chemical compounds as potential drugs against malaria and other parasitic disease. Proposed compounds are to be prepared in sufficient quantities for *in vitro* and *in vivo* testing (about 3 grams each), and submitted to the USAMRDC for biological evaluation. Sufficient examples of the proposed compounds are to be prepared under Phase I to evaluate the area (class of compounds) and only those demonstrating biological activity in the test systems utilized will be considered for further development (Phase II). Phase II objective is the further development of active compounds and/or chemical class of compounds.

A89-075

TITLE: Synthesis of Potential Anti-Chemical Warfare (CW) Agents

DESCRIPTION: The objectives are the design and synthesis of new or novel chemical compounds as potential anti-chemical warfare agents, especially for vesicants (sulfur mustard and cyanide).

Proposed compounds are to be prepared in sufficient quantities for *in vitro* testing and are to be submitted to USAMRDC for biological evaluation. Sufficient examples of the proposed compounds are to be prepared under Phase I to evaluate the area (class of compounds) and only those demonstrating biological activity in the test systems utilized will be considered for further development (Phase II). Phase II objective is the further development of active compounds and/or chemical class of compounds.

A89-076

TITLE: Nozzle Assembly for Army Mass Delousing Outfit

DESCRIPTION: A requirement exists to dispense a metered amount of insecticide during mass human delousing operations. A nozzle assembly capable of dispensing 2-4 grams of talcum powder per shot needs to be developed. The gun must be powered by a Kioritz Model DM-9 backpack sprayer.

A89-077

TITLE: *In Vitro* Dermal Toxicity Screening Tests

DESCRIPTION: Phase I: Develop short-term *in vitro* dermal toxicity screening tests for Army-relevant chemicals utilizing human cells. Phase I Product: Report describing screening test methodologies. Phase II: Perform validation studies on the screening tests to establish their accuracy and precision in detecting potential dermal toxicants. Phase II Product: Report describing the results of the validation studies on the screening test.

A89-078

TITLE: *In Vitro* Respiratory Toxicity Screening Tests

DESCRIPTION: Phase I: Develop permanent functionally differentiated rodent and/or human cell lines derived from respiratory tissue for use in short-term *in vitro* respiratory toxicity screening tests for Army-relevant chemicals. Phase I Product: Report describing methods for production of cell lines. Phase II: Develop short-term *in vitro* respiratory toxicity screening tests utilizing cell lines developed in Phase I; perform preliminary validation studies on the screening tests to establish their accuracy and precision in detecting potential respiratory toxicants. Phase II Product: Report describing methods for screening tests and the results of the validation studies.

A89-079

TITLE: Characterizing Soldier Responses to Irritant Gases

OBJECTIVE: Provide a quantitative definition of soldier performance degradation resulting from exposure to irritant gases from guns and rockets.

DESCRIPTION: Irritant gases (HCl, NH_3, formaldehyde, etc.) associated with weapon systems exhaust emissions are known to produce performance decrements under certain circumstances. Evaluation of soldiers' response to irritation stimuli resulting from exposure to these gases is complicated by the variability of duration of the exposures at a given concentration, by the intermittence of exposures, and acclimation to them, and by ambiguities in the definition of a

performance decrement. The research should use an innovation approach to derive a useful quantitative definition of human performance degradation in response to irritant gases and should address the problems associated with using animal tests to predict performance effects in humans. It should also provide a practical demonstration of responses to exposure to one or more irritant gases, using animal and human tests to evaluate the relationship of responses that affect the ability to perform military tasks to the concentration of the gas and the duration of exposure. Phase II of the project should validate the performance degradation model with more extensive tests using additional irritant gases and should evaluate the effects of acclimation, tolerance, and intermittent repetitive exposures upon performance.

A89-080

TITLE: Diagnosis of Natural and Induced Diseases of Military Importance

DESCRIPTION: This effort is designed to provide state-of-the-art technology to develop a system for rapid identification and diagnosis of agents or diseases acquired naturally or by exposure to biological weapons. The system will provide for rapid identification of agents/diseases through examination of clinical specimens such as blood, urine, spinal fluid and throat washings. The system should be extremely sensitive, using very specific reagents such as monoclonal antibodies prepared through hybridoma technology. There is interest in production of both monoclonal antibodies, and development and production of synthetic polypeptides for use as immunogens. Methods utilizing the latest in biotechnology techniques should be utilized, such as labeled molecular probes for the identification and analysis of microbes or their products.

A89-081

TITLE: Vaccine Delivery Systems

DESCRIPTION: A requirement exists for immunization methods to include controlled-release systems, carriers, and/or adjuvents compatible with live, attenuated and/or killed vaccines. Requirement is to achieve a high degree of protective immunity with multiple products in a short period of time and with a minimum requirement for multiple dose or booster immunizations. Special emphasis is on development of mucosal immunity.

A89-082

TITLE: Immunoassays and Therapy for Low Molecular Weight Toxins

DESCRIPTION: Development of rapid identification and diagnostic methods for the assay of toxins, metabolities, and analogs. Development of pharmacological therapy that is potentially safe for man following exposure. Therapy should minimally be effective prophylactically but preferably be efficacious after exposure. Production of research quantities (100 - 1,000 mg) of toxins noted below.

Toxins of major interest include low molecular weight protein and non-protein toxins such as algal toxins (microcystin, anatoxin A, saxitoxin, gonyautoxin, ciguatoxin, maitotoxin, brevetoxin, palytoxin, lyngbyatoxin, debromoaphlysiatoxin), vertebrate toxins, (tetrodotoxin, batrachotoxin) and protein and peptide toxins of other biological origin, including pre- and postsynaptic neurotoxins,

protein synthesis inhibitory toxins and membrane active substances. There is no interest in the trichothecene mycotoxins.

A89-083

TITLE: Ocular Protection from Laser Hazards

DESCRIPTION: A requirement exists to provide ocular protection to troops at risk from laser energy exposure and ballistic fragments. The US Army is interested in research and development to improve concepts, devices and mechanisms that offer substantial ocular protection from multiple laser wavelengths without degrading essential visual performance. Techniques developed should be adaptable to standard spectacle, goggle, and visor configurations. End items should be resistant to abrasion and impact from ballistic fragments.

PHASE I - Identify a viable concept or device with sufficient laboratory data to demonstrate feasibility.

PHASE II - Further develop the concept of device and deliver a device for Government testing.

A89-084

TITLE: High Duty Cycle, High Power X-Ray Tube for Medical Imaging

DESCRIPTION: Present x-ray tube technology being used for combat medical imaging is a variation of conventional solid rotating anode design. Combat trauma imaging requires a high duty cycle tube. Heat unit over load is a major consideration. Accordingly, we are seeking improved design and engineering remedies for development of a high-heat-load, high-power combat x-ray tube to be used in radiographic fluoroscopic and computer tomography devices.

ISC—ARMY INSTITUTE FOR RESEARCH IN MANAGEMENT INFORMATION, COMMUNICATIONS, AND COMPUTER SCIENCE

A89-085

TITLE: Distributed System Simulation Performance Improvements Through New Algorithmic Modeling and Hardware Architectures

DESCRIPTION: This research involves the use of parallel processors or transputers to simulate distributed system environments. The first step in building the model would involve developing simulations, or emulations where possible, of all the resources in the environment to be modeled. Each of the corresponding simulations of these resources will be mapped onto a separate process on the parallel processor so that it can be run concurrently with any of the other simulations. With this system, a high level of accuracy will be possible, with the data being collected in real or hyper time.

The first phase of this research will develop the structure of the algorithms that would make up the parallel processor distributed system model, collect or develop the necessary simulations of resources to describe a potential distributed system environment, and demonstrate the functionality of the above model. The second phase will develop the model to the point that highly accurate simulations of large distributed systems can be performed.

A89-086

TITLE: Decision Making In A Geographically Distributed Environment

DESCRIPTION: Decision making does not occur in isolation. Rather, decision making is a highly interactive process involving idea sharing, and the identification of constraints, relationships, and alternatives. In the Army groups of individuals provide information and participate in the process leading to the final decision. Decision Support Systems (DSS) or decision aids have been built to help individuals in the decision process, and work has been conducted to help groups of decision makers that are co-located. Very little has been done to support groups of decision makers that are geographically distributed. The increased availability of computer networks opens new opportunities for the support of this process with Group Decision Support Systems (GDSS). Research needs to be conducted that will utilize the computer networking environment in innovative ways to increase the quality and speed of decisions make by distributed decision makers. In Phase II of this project the Phase I results would be applied to a real Army problem which contains geographically distributed decision makers.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of the Chief of Naval Research. The Navy SBIR program manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR program manager's attention and should be addressed to:

Office of the Chief of Naval Research
Attn: Mr. Vincent D. Schaper, Navy SBIR Program Manager
800 North Quincy Street (BCT #1, Room 934)
Arlington, VA 22217-5000
(202) 696-4286

The Navy has identified 213 technical topics to which small R&D businesses may respond. A brief description of each topic is included along with the address of each originating office. This information is contained on the ensuing pages.

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Topics #N89-1 through #N89-8

Mail/Handcarry Address:

Office of Naval Research
Attn: ONR Code 1111MA, Rm. 607
SBIR Program, Topic No. N89-____
800 N. Quincy Street, BCT#1
Arlington, VA 22217-5000

Topics #N89-9 through #N89-15

Mail/Handcarry Address:

Office of Naval Technology
Attn: ONT Code 20T, Rm. 502
SBIR Program, Topic No. N89-____
800 N. Quincy Street, BCT#1
Arlington, VA 22217-5000

Topic #N89-16

Mail Address:

Commanding Officer
MCRDAC, SBIR Program
Amphibious Warfare Technology Directorate
Quantico, VA 22134-5080

Handcarry Address:

MCRDAC, SBIR Program, Topic No. N89-____
Amphibious Warfare Technology Directorate
Lucas Hall, Room 9
Marine Corps Base
Quantico, VA

Topics #N89-17 through #N89-59

<u>Mail Address:</u>

Commander
Space and Naval Warfare Systems Command
Department of the Navy
Attn: SPAWAR 10D, SBIR Program, Topic No. N89-____
Washington, DC 20363-5100

<u>Handcarry Address:</u>

Space and Naval Warfare Systems Command
National Center #1, Room 1E58
2511 Jefferson Davis Highway
Attn: SPAWAR 10D, SBIR Program, Topic No. N89-____
Arlington, VA

Topics #N89-60 through #N89-67

<u>Mail Address:</u>

Commander
Naval Supply Systems Command
Department of the Navy
Attn: Code PML-5505, SBIR Program, Topic No. N89-____
Washington, DC 20376-5000

<u>Handcarry Address:</u>

Naval Supply Systems Command
Attn: Code PML-5505, SBIR Program, Topic No. N89-____
Crystal Mall #3, Room 515A
1931 Jefferson Davis Highway
Arlington, VA

Topics #N89-68 through #N89-70

<u>Mail Address:</u>

Commanding Officer
Naval Medical Research & Development Command
Attn: Naval Medical Command, National Capital Region
SBIR Program, Topic No. N89-____
Bethesda, MD 20814-5044

<u>Handcarry Address:</u>

Naval Medical Research & Development Command,
Naval Medical Command, National Capital Region
Bldg. #1 (The Tower), Room 12147
Attn: SBIR Program, Topic No. N89-____
Bethesda, MD

Topics #N89-71 through #N89-83

<u>Mail Address:</u>

Headquarters, Naval Air Systems Command
Department of the Navy
Attn: Code AIR-9303D, SBIR Program, Topic No. N89-____
Washington, DC 20361-9301

<u>Handcarry Address:</u>

Headquarters, Naval Air Systems Command
Department of the Navy
Jefferson Plaza #1, Room 472
1411 Jefferson Davis Highway
Attn: Code AIR-9303D, SBIR Program, Topic No. N89-____
Arlington, VA

Topics #N89-84 through #N89-128

<u>Mail Address:</u>

Commander
Naval Sea Systems Command
Department of the Navy
Attn: Code CET-4, SBIR Program, Topic No. N89-____
Washington, DC 20362-5101

<u>Handcarry Address:</u>

Commander
Naval Sea Systems Command
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Attn: Code CET-4, SBIR Program, Topic No. N89-____
Arlington, VA

Topics #N89-129 through #N89-163

<u>Mail Address:</u>

Commander
Naval Surface Weapons Center
White Oak Laboratory
Attn: Code S-02, SBIR Program, Topic No. N89-____
Silver Spring, MD 20903-5000

<u>Handcarry Address:</u>

Commander
Naval Surface Weapons Center
White Oak Laboratory
Bldg. #1, Reception Room
Attn: Code S-02, SBIR Program, Topic No. N89-____
Silver Spring, MD

Topics #N89-164 and #N89-165

Mail Address:

Commander
Naval Surface Weapons Center
Dahlgren Laboratory
Attn: Code S12, SBIR Program, Topic No. N89-____
Dahlgren, VA 22443-5000

Handcarry Address:

Commander
Naval Surface Weapons Center
Dahlgren Laboratory
Bldg. #962, Room 129
Attn: Code S12, SBIR Program, Topic No. N89-____
Dahlgren, VA

Topic #N89-166

Mail Address:

Commanding Officer
Naval Weapons Support Center
Attn: Code 6053, SBIR Program, Topic No. N89-____
Crane, IN 47522-5060

Handcarry Address:

Commanding Officer
Naval Weapons Support Center
Bldg. #2917
Attn: Code 6053, SBIR Program, Topic No. N89-____
Crane, IN

Topics #N89-167 through #N89-171

Mail Address:

Commander
Naval Weapons Center
Attn: Code 005, SBIR Program, Topic No. N89-____
China Lake, CA 93555-6001

Handcarry Address:

Commanding Officer
Naval Weapons Center
515 Blandy Avenue, Room #22
Attn: Code 005, SBIR Program, Topic No. N89-____
China Lake, CA

Topics #N89-172 through #N89-176

<u>Mail Address:</u>

Commander
Naval Air Development Center
Attn: Code 094, SBIR Program, Topic No. N89-____
Warminister, PA 18974-5000

<u>Handcarry Address:</u>

Commander
Naval Air Development Center
Bldg. #3
Attn: Code 094, SBIR Program, Topic No. N89-____
Warminister, PA

Topics #N89-177 and #N89-178

<u>Mail/Handcarry Address:</u>

Commercial Acquisition Department
Naval Underwater Systems Center
Shaws Cove Office Park, Bldg. #4
Howard Street
New London, CT 06320-5594
Attn: Code 911, SBIR Program, Topic No. N89-____

Topics #N89-179 and #N89-180

<u>Mail Address:</u>

Commanding Officer
Naval Air Engineering Center
Attn: Code 073, SBIR Program, Topic No. N89-____
Lakehurst, NJ 08733-5000

<u>Handcarry Address:</u>

Commanding Officer
Naval Air Engineering Center
Bldg. #26
Attn: Code 073, SBIR Program, Topic No. N89-____
Lakehurst, NJ

Topics #N89-181 through #N89-184

Mail Address:

Commander
Pacific Missile Test Center
Attn: Code 3154, SBIR Program, Topic No. N89-____
Point Mugu, CA 93042-5000

Handcarry Address:

Commander
Pacific Missile Test Center
Bldg. #514, Room #113
Attn: Code 3154, SBIR Program, Topic No. N89-____
Point Mugu, CA

Topics #N89-185 and #N89-186

Mail Address:

Commander
Naval Training Systems Center
Attn: Code 6, SBIR Program, Topic No. N89-____
Orlando, FL 32813-7100

Handcarry Address:

Commander
Naval Training Systems Center
Bldg. #2005, Reception Area
Attn: Code 6, SBIR Program, Topic No. N89-____
Orlando, FL

Topics #N89-187 through #N89-189

Mail Address:

Commanding Officer
Naval Coastal Systems Center
Attn: Code 401, SBIR Program, Topic No. N89-____
Panama City, FL 32407

Handcarry Address:

Commanding Officer
Naval Coastal Systems Center
Bldg. #110 (Main Administrative Bldg.), Rm 2M72
Attn: Code 401, SBIR Program, Topic No. N89-____
Panama City, FL

Topics #N89-190 and #N89-191

Mail Address:

Commanding Officer
Naval Civil Engineering Laboratory
Bldg. #560
Attn: Code L03B, SBIR Program, Topic No. N89-____
Maritime Road & Market Street
Port Hueneme, CA

Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Bldg. #560
Attn: Code L03B, SBIR Program, Topic No. N89-____
Maritime Road & Market Street
Port Hueneme, CA

Topics #N89-192 through #N89-199

Mail Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE1A, SBIR Program, Topic No. N89-____
P.O. Box 7176
Trenton, NJ 08628-0176

Handcarry Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE1A, SBIR Program, Topic No. N89-____
1440 Parkway Avenue
Trenton, NJ

Topics #N89-200 through #N89-209

<u>Mail Address:</u>

Commander
Naval Ocean Systems Center
Attn: Code 0141, SBIR Program, Topic No. N89-____
San Diego, CA 93555

<u>Handcarry Address:</u>

Commander
Naval Ocean Systems Center
271 Catalina Boulevard, Trailer 28T
Attn: Code 216B-Supply Annex,
SBIR Program, Topic No. N89-____
San Diego, CA

Topic #N89-210

<u>Mail Address:</u>

Commander
David Taylor Naval Ship
Research & Development Center
Attn: Code 011.4, SBIR Program, Topic No. N89-____
Bethesda, MD 20084-5000

<u>Handcarry Address:</u>

Commander
David Taylor Naval Ship
Research & Development Center
Attn: Code 011.4, SBIR Program, Topic No. N89-____
Bldg. #2, Room 109
Carderock, MD

Topics #N89-211 through #N89-213

<u>Mail Address:</u>

Commander
Naval Air Test Center
Attn: Code CT22, SBIR Program, Topic No. N89-____
Patuxent River, MD 20670

<u>Handcarry Address:</u>

Commander
Naval Air Test Center
Bldg. #304
Attn: Code CT22, SBIR Program, Topic No. N89-____
Patuxent River, MD

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OFFICE OF NAVAL RESEARCH

N89-001 TITLE: Language Based Software Environments

CATEGORY: Research

DESCRIPTION: Language-based software development environments can improve productivity by making effective use of knowledge specific to the particular language being used, be it a programming language, a specification language, or mathematical logic. Techniques for generating language-based environments from formal specifications have been developed in the research community. Prototypes exist that demonstrate the viability of the various approaches for creating such systems. But no fully-engineered products exist. Because an environment generator is a tool-building tool, considerable leverage would be obtained by perfecting such a system. In particular, one efficient implementation of an environment generator has the potential to lead to efficient environments for a multitude of languages. The introduction of Ada into military systems and the special environments for system development will cause, for the foreseeable future, a mixture of CMS-3 and Ada developments to maintain fleet software. Multilingual environments are guaranteed to exist in some form that maintain the independence of each. Integration of tools to a higher level of utility by using language-specific information is a worthwhile goal.

N89-002 TITLE: Autonomous Marine Instrumentation Platforms

CATEGORY: Research

DESCRIPTION: The objective of this task is to develop innovative methods for deploying and operating autonomous, in-situ oceanographic instrumentation packages to measure surface and near-surface (up to 20m depth) physical, biological and/or chemical parameters. Measured quantities of interest will include high wavenumber surface wave spectra, near-surface profiles of steady and fluctuating velocities together with surface and subsurface concentrations of chemical species and bubble populations. The proposed platform concepts to achieve these types of measurements will need to incorporate the means to suppress and/or to account for platform motions in order to reference all fluctuations to an appropriate (local) inertial frame.

N89-003 TITLE: Acoustic Classification with Parallel-Processing Networks

CATEGORY: Research

DESCRIPTION: The objective of this task is to develop a prototype system utilizing parallel-processing networks that interface with a human operator whose objective is to determine the source of a non-speech acoustic signal from its transient characteristics. The size of the signal set should be at least 20 sounds. The exploitation of artificial neural network or neuro-computer systems is encouraged. The development

of connectionist models of this task is of interest. Studies should lead to an understanding of how users interact effectively with concurrent informational flows, the conditions that significantly influence that process, and the allocation of decision-making between the user and this automatic processor.

N89-004 TITLE: Advanced Biosensors

CATEGORY: Research

DESCRIPTION: Biological systems have the inherent ability to sense and respond selectively to small concentrations of specific chemical species. Examples include: mammalian olfaction processes, insect pheromone detection, and ion channel gating in membranes. Recent advances in molecular recognition, biocatalysis, and the ability to isolate and reconstitute cell components (e.g., ion channels, receptors) into artificial host materials offer an opportunity to develop sensing elements that have many of the capabilities of biological systems. The objective of this program is to develop highly selective and sensitive sensors which exploit these new developments by coupling the selective chemistry with optical, electrochemical and other amplification schemes. Ultimately, these biomimetic sensors could be used to detect substances of abuse, hostile agents, and naturally occurring substances, e.g., neurotransmitters.

N89-005 TITLE: Novel Growth Techniques for Large Area SiC Substrates

CATEGORY: Research

DESCRIPTION: Investigation of novel growth/deposition techniques to provide Beta-SiC high performance device-quality thin films on crystalline insulator substrates. State-of-the-art growth techniques for Beta-SiC are limited in size and prone to high density stacking faults. The projected research effort will address suitable substrates with or without intermediate layers to achieve proper coordination number and reduce crystalline defects at the interface and their propagation throughout the films. The resulting layers over 75 to 100-mm diameter substrates will be characterized for their physical properties; e.g., electron and hole mobilities, crystalline perfection and their use for high performance (radiation tolerant, high temperature) microwave and millimeter wave devices.

N89-006 TITLE: Novel Approaches to the Synthesis of Fluorodinitromethane and Fluorodinitroethanol

CATEGORY: Research

DESCRIPTION: A number of compounds containing the fluorodinitromethyl group are used as energetic plasticizers and polymers in high performance explosive compositions. The use of these materials is restricted by their high cost. Increased benefits from the high energy content and excellent

stability of these materials could be realized for a wider range of Navy munitions if their cost could be reduced. For these reasons, novel synthesis methods for the key precursors, fluorodinitromethane and 2,2,2-fluorodinitroethanol, are sought which are not based on nitroform or 2,2-dinitropropanediol as starting materials. Alternatively, the novel methods may derive from nitroform or 2,2-dinitropropanediol if improved production methods for these two materials are being proposed also as an integral part of the project.

N89-007 TITLE: Production and Coating of Pure Boron Powders

CATEGORY: Research

DESCRIPTION: Develop processing chemistry to synthesize pure boron powder coated with protective metal films for ultimate use in high energy propellants and underwater explosives. Boron particle diameters in the range of 0.5 to 50 microns are desired that are coated with protective metallic films of magnesium, titanium or zirconium. The protective metallic coatings must be applied to the particles prior to exposure to air or water to prevent boron oxide formation on the surface during subsequent handling and in early stages of combustion. The protective coating thickness must be consistent with the particular diameter so that the combustion energy is not reduced by more than about 10% from that of pure boron. The process should lend itself to full-scale production of coated pure particles with a high integrity of surface coating and uniform diameter. High uncoated boron particle purity is required for both research and development purposes to optimize, improve and control the reactivity, burning rate and combustion efficiency of boron- containing energetic propellants and explosives.

N89-008 TITLE: Novel Acoustic Damping Materials

CATEGORY: Research

DESCRIPTION: There is a need for improved materials having a high damping capacity combined with good mechanical properties, suitable for structural uses. Of primary interest are novel directionally isotropic metal matrix composite materials (i.e., not containing aligned reinforcing fibers) which can potentially provide rapid attenuation at vibrational frequencies of from 1 to 1000 Hz. Also of interest are materials that are active over a broad temperature range, at room temperature and above. Advanced processing approaches to produce novel microstructures and/or unusual metal/ceramic or metal/organic mixtures are encouraged.

OFFICE OF NAVAL TECHNOLOGY

N89-009 TITLE: Deception Methods for Rule-Based Decision Aids in Adversarial Environments

CATEGORY: Exploratory Development

DESCRIPTION: Automatic aids for situation assessment, for planning and for information fusion contain symbolic, principally rule-based, inference methods. A primary aspect of military situations is the use of deception in local and global strategies. Deception, if it is done well, produces logically consistent events and stimuli to the sensors of an adversary. This logical consistency, although fictitious, produces inference in decision aids which are the basis for a response based on "apparent truth." The need exists for methods to manage the inference process in order that multiple hypotheses can be retained in the computations without an unacceptable overhead burden. Evidential reasoning and computational structures are key dimensions of the problem, with an added dimension being that of observation noise. Proposal should address methods for including deception patterns in decision aids when in the presence of observation noise and computational constraints.

N89-010 TITLE: Microwave Monolithic Integrated Circuits (MMIC) Passive Components

CATEGORY: Exploratory Development

DESCRIPTION: MMIC operating at "L" band need filters and isolators that are high performance, yet compatible with MMIC technology. Isolators can be made using cascade amplifiers. These circuits can provide isolation in excess of 50 dB at "L" band, but noise figures and compression points are limitations. Low compression power implies the use of the isolator at low input power levels where the noise figure needs to be low. Novel MMIC techniques are needed to generate a non-reciprocal transfer function with low noise figures and high power compression points. Filters can be designed using lumped element approaches, spiral inductors and Metal-Insulator-Metal (MIM) capacitors, and the gate-to-source capacitance of a single gate MESFET can be utilized to tune the filter response moderately. The design limitation on these filters is low "Q". Techniques are needed to improve the Q-factors of these elements. Active techniques are required to generate large inductors as are used in low-frequency gyrator circuits.

N89-011 TITLE: Single Crystal Titanium Carbide

CATEGORY: Exploratory Development

DESCRIPTION: Develop a reproducible, high yield process for production of single crystal titanium carbide ingots of controlled composition and orientation. Ingots should be 2 inches in diameter and 12 inches long with large, pure single crystal regions from which uniform wafers can be

sliced in high yield. Composition should be chosen to provide good lattice matching with silicon carbide, for which this titanium carbide will be a substrate.

N89-012 TITLE: Expert System for Joining Composite Materials

CATEGORY: Exploratory Development

DESCRIPTION: A wide variety of composite material joining procedures and techniques have been used and tested. However, many design engineers do not have easy access to this wealth of information. As a consequence, the designer of a composite structure or component may not make the optimum joining procedure decision during the design stages. This leads to inefficient designs, and to costly problems in the fabrication and production stages. It is desired to have an expert system developed to assist designers in the optimum selection of composite material joining techniques. Such a system must incorporate an extensive data base of composite material joining details and procedures and be capable of developing an optimum, or near optimum, joining design and procedure for the user. The system should operate in a desktop computer environment and have the ability to provide alphanumeric data, as well as design drawings and other graphical information to the user.

N89-013 TITLE: Helium Dewar System for Superconducting Sensors

CATEGORY: Exploratory Development

DESCRIPTION: Requirements exist for the development of a helium dewar that will have substantially improved performance over those currently used for prototype development. Need dictates that the dewar be extremely efficient in terms of space, thermal leakage and weight. Phase I of this effort requires a study of new technologies and techniques to be used in construction of miniaturized dewars, including the possibility of incorporating a closed-cycle refrigerator. At a minimum, the topics to be addressed will include thermal efficiency, hold time, magnetic signature, antislosh baffling and size. A dewar is then to be designed based upon the initial study with the capability of cooling a sensor system with physical characteristics that will be provided by the funding agency. In phase II, the resulting dewar will be constructed and evaluated.

N89-014 TITLE: Detection of Acoustic Non-Gaussian Signals

CATEGORY: Exploratory Development

DESCRIPTION: Methods of passive acoustic signal processing have generally assumed either a known signal or a Gaussian signal embedded in Gaussian noise. In an era when radiated ship noise is being dramatically reduced, investigations of maximum likelihood or other "optimum" methods for detection of less traditional, non-Gaussian signals in Gaussian noise are important tasks. A few statistical theories have been advanced, but not

applied to real acoustic operational data to determine the transition potential of the theories. Approaches to this problem may be principally ad hoc and dependent upon reasonable models of the signal and signal plus noise processes. Evaluations of the methods advanced according to suitably defined measures of effectiveness should form the focus of work proposed within this topic.

N89-015 TITLE: Torpedo Detection System

CATEGORY: Exploratory Development

DESCRIPTION: Develop non-acoustic means of detecting and localizing torpedoes using shipboard sensors. System shall be capable of operating on current U.S. ships without restricting operating environments or tactics. The system shall be capable of detecting and localizing torpedoes operating against surface ships from all angles on the bow and against all classes of torpedoes.

MARINE CORPS

N89-016 TITLE: Sealed Tube Technology for Metal Vapor Lasers

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists for the development of a sealed laser tube for a Copper Vapor Laser (CVL). A sealed type CVL would substantially improve performance over current state-of-the-art CVLs by eliminating the flow-through buffer gas system consisting of compressed gas and a vacuum pump, as well as increasing the operation times, as periodic tube breakdown for copper replacement would be eliminated. Phase I of this effort requires a study (and possible demonstration) of new technologies and techniques required for the fabrication of a sealed tube. At a minimum, this shall address the technology required to seal ceramics to dissimilar materials (e.g. alumina to niobium and alumina to sapphire) with vacuum seals capable of high temperature (1500°C) operation. Based on the study results, a CVL would be made available for this purpose. In phase II, the resulting tube is to be fabricated and evaluated.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N89-017 TITLE: Warfare Systems Architectures

CATEGORY: Exploratory Development

DESCRIPTION: Naval warfare strategies and systems acquisitions are undergoing deliberate change in the Navy. Stand-alone systems, interoperability issues and adverse programming actions are a few of the reasons giving rise to these deliberations. The Navy is presently examining a top-down approach to R&D and acquisition decisions, guided by Top Level Warfare Requirements (TLWRs). The conceptual framework of a

Warfare Systems Architect and Engineer (WSA&E) has been formed to relate the Navy's warfare strategies and systems acquisitions. The architecture level focuses on TLWR compliance. Rigorous mission analysis, force level perspectives and systems architectures are the end products. The systems engineering level is aimed at programs. The architectures are systems engineered, wherein they are translated into program level guidance across platform and warfare mission areas. Performance specs, controlled interface drawings and test specs are established. The purpose of this task is to seek innovative assistance at the architectural level. The systems architectures address 12 warfare mission areas: Command (communications), C2, Strike Warfare (STW), Anti-Surface Warfare (ASUW), Amphibious Warfare (AMW), Anti-Air Warfare (AAW), Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Electronic Warfare (EW), Special Warfare (SW), Space, and Logistics. The force structures to implement these warfare missions include the Carrier Battle Force (CVBF), Battleship Battle Group (BBBG), Amphibious Task Force (ATF), Area ASW Force, and SLOC Protection Force. Proposals should identify a single mission area; multiple proposals may be submitted. The architectural process involves four steps: 1) Functional decomposition of the mission entails decomposing the mission into tiers, establishing Required Operational Functions, devising functional flow diagrams, and building a complete data base. 2) Physical analysis of the current force (e.g., complete understanding of the platforms, systems interdependencies and Battle Force C2 requirements); allocating ROFs to platforms; composing a baseline warfare systems architecture; establishing functional shortfalls of the baseline architecture and adding FYDP programs. 3) Performance examines the Architecture vs TLWR, via models and war-gaming, and establishes performance shortfalls. Identify shortfall resolutions, such as systems upgrades, notional platforms, etc. This step is reiterated and refined. 4) Architecture Options establish WSA&E products, which include Force Level Architectures, TLWR compliant options such as costs, performance, schedule, risk, technology, payoff.

N89-018 TITLE: Advanced Systems and Concepts for Future Naval Warfare

CATEGORY: Exploratory Development

DESCRIPTION: Throughout the history of military conflict innovative technology in the hands of resourceful leadership has proved to be an unequaled force multiplier. This task seeks new ideas in high payoff, high risk technologies, systems, systems architectures, and warfare concepts addressing Naval Battle Force Warfare in the years 2000 and beyond. The Battle Force must be capable of mission execution and defense in a multiplicity of warfare areas (e.g., AAW, ASW, ASUW, MIW, C3I, etc.) involving a multiplicity of subsurface, surface, aerospace and space platforms. The end products being sought are detailed assessments of 1) the advanced systems and architectures supportive of Navy mission areas, 2) the warfare concept and operational advantages offered the Battle Force, 3) the new and existing technologies required, 4) projected costs, and 5) risks. Phase I proposals should outline a clear methodology to achieve these goals. Imaginative, realistic ideas are encouraged.

Offerors may submit as many proposals as deemed appropriate to cover their varied ideas for advanced systems and concepts of future Naval warfare. Multiple contract awards to a single offeror and awards to more than one offeror are contemplated.

N89-019 TITLE: Expert System for Development of Request for Proposal Packages

CATEGORY: Exploratory Development

DESCRIPTION: Development of Request for Proposal packages is generally a manual process involving integration of inputs from program managers, contracting officers and other various government managers. Since the packages often include standard language for statements of work, provisions and clauses, the efficiency for developing the packages could be improved by automating these sections. In addition, automation should improve the efficiency of package development and reduce the number of omissions and errors by incorporating internal automated checklists. The Navy has a requirement for development of an expert system to accommodate development of Request for Proposal packages using standard language, as well as providing the user flexibility for tailoring various sections of the package.

N89-020 TITLE: Using Differential Global Positioning System for Truth Reference

CATEGORY: Engineering Development

DESCRIPTION: The need for a precise truth reference system exists for harbor navigation, rescue and salvage, and very precise tactical applications. A design approach and systems demonstration for a differential Global Positioning System for this purpose should be investigated. The use of nondevelopment item technology with Navy standard 3S Global Positioning System equipment would be the focus of the study. This study would investigate potential cost and other advantages associated with the proposed configurations. Possibilities also exist for sensor calibration for equipment operating within the common grid system.

N89-021 TITLE: Jamming Techniques Against Frequency Hopping Signals

CATEGORY: Advanced Development

DESCRIPTION: Timely generation of effective jamming against frequency hopping signals allows only a short time to measure the target signal parameters. Since measurement precision is inversely proportional to time, certain target signal parameters will not be measured to the precision required to generate the best jamming signal. It is the lack of precision that encourages he selection of wideband jamming waveforms in order to be sure of overing the target signal(s). Wide-band jamming waveforms, in general, require more power than narrow-band waveforms to

provide the needed jamming to signal ratio at the target receiver in a naval battle group scenario. An investigation is desired to develop jamming waveforms that do not require precise knowledge of signal parameters nor unduly high power, and that will provide effective jamming of specific modulations and signal types with their associated receivers. The investigation will be analytical and experimental (at a NAVOCEANSYSCEN laboratory). The work will be done at the SECRET level.

N89-022 TITLE: Stochastic Time Attributed Petri Network (STAPN) Modeling of C3 Networks

CATEGORY: Exploratory Development

DESCRIPTION: There is a Navy need for the capability to assess the performance of future Anti-Submarine Warfare (ASW) Command, Control and Communications (C3) architectures and, through the incorporation of advanced organizational and data/information management concepts, assess their ability to improve war-fighting effectiveness. This task involves developing a technique for modeling Naval C3 networks which will allow the analysis of network performance and comparison of alternative C3 architectures. The technique should allow for the characterization and display of the C3 flow in Naval Command structures. It should include parameters associated with the decomposition of warfare functions (in the mission domain), command functions (in the organization domain), and system functions (in the resource domain). A set of representative scenarios should be established, spanning the range of military conflict from limited crisis to global war, to test each architecture, and measures of effectiveness (MOEs) for performance comparisons should be developed. These MOEs should include command as well as communication capabilities. This technique should also include the development of data dictionaries containing baseline functional decompositions of Naval staffs, warfare areas, and ASW platforms. The technique should be compatible with the ASW Test Bed Model specifications and should allow for the creation and assessment of hypothetical systems and operating concepts.

N89-023 TITLE: Anti-Submarine Warfare (ASW) Command, Control, Communications and Intelligence (C3I) Model Development

CATEGORY: Exploratory Development

DESCRIPTION: The Naval Warfare Systems Architect needs a means of structuring Battle Force/Battle Group (BF/BG) Architecture, as well as assessing the war-fighting capability of current and future architecture. Additionally, the Composite Warfare Commander needs a means of determining the performance of his C3I systems. The objective of this effort is to develop an event- driven, variable time step ASW Monte Carlo C3 model. The model shall consist of at least the following principal sub-models: Data Fusion--fuse ASW data from organic and non organic sources; Resources Allocation--ASW resource allocation and prioritization, including man,

weapons and sensors; Communications--model time late, alternate network paths and connectivity, network countermeasures and degraded modes of operation; Input Message Processing--simulate message processing; Track Correlation-- correlation of track file with sensor(s); Target Classification--target ranking and weapon assignment; Engagement--simulate encounter results; and Data Acquisition and Data Base Management -- simulate data acquisition and management. The model must be high fidelity. Sub-models must run in a parallel, time synchronous, near-real-time mode. The model outputs shall be usable measures of effectiveness. The end result of this task will be: a literature search and requirements analysis, and model development risk assessment; and a top-level development of the physics of the model. Phase II, if required, will consist of: complete development of the physics of the model; and application of top-down structured design to model development, model coding, model runs and fidelity demonstration and model documentation.

N89-024 TITLE: Effects of Compiler and Run-Time System Features on Future Combat Systems Designs

CATEGORY: Exploratory Development

DESCRIPTION: There has been considerable work undertaken in the development of Ada tools, compilers, and environments. The primary intent of Ada was for use as the language for combat systems. However, the ability to use Ada in these real-time embedded systems is just now being explored. There is a need to examine the run-time support required by combat systems using Ada. The purpose of this effort is to evaluate one or more combat systems under development and to identify the run-time support required if the system were to use Ada. The run-time support includes the Ada run-time executive, debugger tools, hardware, and any underlying operating systems. It is important to identify the areas in which run-time support is expected to be deficient. The Department of Defense (DoD) requires guidance for the development of comprehensive and efficient run-time systems that can support actual combat systems.

N89-025 TITLE: Improve Electronic Warfare (EW) Response Time

CATEGORY: Advanced Development

DESCRIPTION: Modern communications are going more to wideband techniques, and modern usage of single channel techniques is becoming less predictive of frequencies for use. These factors lead to the need to perform an instantaneous broadband search and rapid processing of the search data in order to detect and identify signals of interest with sufficient speed to perform countermeasures before the signal ends or changes frequency. There are many noise sources of interference and many signals not of interest that, along with the signals of interest, provide a highly complex output from a wideband receiver. Techniques are sought that can recognize patterns and associate signals at various Radio Frequencies (RFs), in time, to a particular transmission (an RF hopper) and to do so for multiple simultaneous transmissions in the noisy and busy environment

with sufficient speed and accuracy to drive a jammer (follower jammer against a hopper). New and fresh approaches are sought, such as neuronets or expert systems. Work will be at the SECRET level.

N89-026 TITLE: Standard Software Environment for Local Area Network (LAN) Integration

CATEGORY: Exploratory Development

DESCRIPTION: In the near future, communication among elements of shipboard combat systems will be supported by high-speed fiber optic Local Area Networks (LANs). LANs permit a high degree of interconnectivity between all elements of the combat system and provide the flexibility to implement future changes without expensive and disruptive hardware modifications to input-output (I-O) channels or unit-to-unit cabling. The intended flexibility cannot be realized, however, if extensive software changes need to be made whenever a combat system element is to be adapted from one application to another. What is needed is a novel and innovative approach to standardization of the ISO/OSI Level 6 Presentation Layer in a manner which would insulate the Level 7 Applications Programs from the lower level protocols which are network dependent.

N89-027 TITLE: Frequency Agile Laser Protective Devices

CATEGORY: Exploratory Development

DESCRIPTION: With the increasing development of lasers throughout the visible spectrum, there is a need for a single filter that will protect the eyes of personnel against all laser wavelengths. Such a frequency agile laser protective device must also provide good daytime and nighttime visibility and not pose other hazards to personnel. In essence, the ideal device must obstruct hazardous levels of laser radiation and allow viewing of light at safe levels for all wavelengths in order to see surroundings, indicator lights and other visual aids, obstacles, etc. This device must understand all Navy Standard environmental testing.

N89-028 TITLE: Software Development System Safety Analysis

CATEGORY: Advanced Development

DESCRIPTION: With the trend to software control of weapons, aircraft, and command and control systems, the potential for a software error causing a catastrophe increases. There is a need for software hazards analysis techniques that can be applied both to program design languages, written code and interfaces between hardware and software. While a survey of existing methods is necessary for background, original work building on state-of-the-art is the desired product.

N89-029 TITLE: <u>Analysis of Xenon-Chloride Laser Gas Contamination Mechanisms</u>

CATEGORY: Exploratory Development

DESCRIPTION: The purpose of this task is to contribute to xenon-chloride laser lifetime and performance by identifying and analyzing the dynamic reactions which result in lasing medium contamination during the operation of xenon-chloride lasers. This task is important for ensuring that xenon-chloride laser transmitters with sufficient performance, lifetime, and reliability will be available for use in the satellite laser communications program. The task will include, but will not be limited to, identification of the materials utilized in xenon-chloride lasers, evaluation of the potential reactions that could occur within and between these materials given the environmental conditions associated with laser hot standby and operation, estimation of the rates of reaction and the likelihood that these reactions would occur, analysis of the effects of by-products and products on the laser and laser performance (ultra violet (UV) absorption, absorber, chlorine consumption, opaque particulate, etc.), and recommendation of alternative materials or techniques to control, prevent, or mitigate the effects of gas contamination.

N89-030 TITLE: <u>Cesium Cell Optimization for Satellite Laser Communications Applications</u>

CATEGORY: Engineering Development

DESCRIPTION: Many factors affect the response, sensitivity, lifetime, and line width of cesium cells. Experience has indicated that currently obtainable cesium cells are not satisfactory for use in satellite laser communication applications. The purpose of this task is to identify those factors which affect the performance of cesium cells, analyze their impact on cells intended for use in satellite laser communication hardware, and optimize cell designs for use in laser transmitters and receivers. The task includes, but is not limited to, investigation of the effects of temperature, buffer gas mixture, buffer gas pressure, materials selection, temperature profile, and device geometry on cesium cell performance. Researchers shall also address cesium cell manufacturing techniques and the development of quality assurance standards and methodology sufficient to ensure the production of reliable cesium cells with consistent performance characteristics.

N89-031 TITLE: <u>Development of All-Sapphire Raman Cells</u>

CATEGORY: Advanced Development

DESCRIPTION: Window Raman cells, containing lead vapor in the temperature range of 1300°C to 1350°C are used in the satellite laser communications program as an optical frequency conversion device. Production of tightly sealed optical windows which demonstrate long calendar life is a topic of continuing interest. One proposed sealing method would employ an all-sapphire tube in which the windows are fused into the cell body. (This

eliminates the need to use frits as seals, which by their nature contain undesired impurities.) The objective of this task is to develop a process that yields fused sapphire cells of the desired size and with windows of the desired optical quality.

N89-032 TITLE: Information Processing Enhancements for the Satellite Laser Communications Systems

CATEGORY: Exploratory Development

DESCRIPTION: Identify and evaluate the performance of candidate techniques for increasing communications throughput, transmitter lifetime, and system connectivity by reducing the number of optical pulses required to convey a given message while maximizing the probability of its successful receipt. Methods to be evaluated will include, but will not be limited to, source coding, channel coding, and adaptive filtering techniques. The studies will also address the effects of spot shape, spot power distribution, spot size, environmental factors, and time delay revisiting on total system performance. All techniques and/or processes to be investigated must be applicable to a pulse position modulation scheme, be compatible with the existing transmitter/receiver design, and be incorporated before the laser transmitter or after the optical detector.

N89-033 TITLE: Long-Term Xenon Chloride Laser Gas Processing

CATEGORY: Research

DESCRIPTION: The satellite laser communications program requires development of xenon-chloride (XeCl) lasers that can support operation in space for three to seven years. Current testing indicates that after a period of operation, a buildup of contaminates within the laser gas reduces laser output power by altering the laser gas mix and by condensation/deposition on the laser pressure vessel optical windows. This task will propose and experimentally verify the efficacy of various gas processing techniques that might be employed in space to minimize the levels of contaminants within the laser. Potential methods include the use of electrostatic precipitators, getters (particularly calcium getters), and cryogenics.

N89-034 TITLE: Effects of High Temperature on Optical Components and Sealing Compounds

CATEGORY: Exploratory Development

DESCRIPTION: Window Raman cells, containing lead vapor at temperatures of 1300°C to 1350°C, are used in the satellite laser communications program as an optical frequency conversion device. Production of tightly sealed optical windows which demonstrate long calendar life is a topic of continuing interest. Concerns exist regarding long-term changes in the crystalline structure of the frits (seals), which may affect cell integrity, as well as the windows themselves, which may affect beam

quality of the optical output. In addition, migration of frit component materials onto the windows degrades long-life optical damage thresholds. This task will determine the long-life performance of various high temperature frits and optical windows (including, but not limited to fused quartz and sapphire) in an environment which simulates the interior of an operating lead vapor Raman cell.

Note: For topics N89-35 to N89-47, the Navy SBIR Communication Support System (CSS) information package is available upon request from the Defense Technical Information Center.

N89-035 TITLE: Techniques for Reconnecting Partitioned Networks

CATEGORY: Advanced Development

DESCRIPTION: As the Navy extends the range of its communication networks by the use of repeaters, it will become necessary to develop techniques for reconnecting networks which have become partitioned due to loss of repeating nodes. A typical example would be where an aircraft that functions as a repeater for a dispersed line-of-sight network is suddenly lost. In this case, the network is divided into small isolated networks. These smaller networks could be reconnected using High Frequency as an internetwork gateway. The issue is to develop protocols which support reconnections that have minimum impact on the users (host computers). The reconnection processes should be transparent to the users. This effort is to develop techniques and simulate performance of reconnection systems.

N89-036 TITLE: Dynamic Internetwork Gateway Algorithms

CATEGORY: Advanced Development

DESCRIPTION: This effort is to develop internetwork gateways that can be dynamically selected to support the use of multiple Radio Frequency (RF) networks for delivery of Navy traffic. The Navy presently has a mix of RF networks such as High Frequency (HF), Ultra-High Frequency (UHF), Line of Sight, Joint Tactical Information Data Systems, Ultra-High Frequency (UHF) Satellite Communications, etc. All ships do not support all networks. A typical example would be the transmission from shore on UHF Satellite Communications of a message destined for a ship that supports only an HF network. In this case, any ship that supports both HF and UHF Satellite Communications could function as an internetwork gateway. The question is, if multiple ships can act as the gateway, which one should be selected? The issue is how much network topology knowledge must be shared between the HF and UHF Satellite Communications networks in order to select a gateway which can most efficiently deliver the required traffic. Overhead for transmitting topology knowledge must also be minimized, particularly as the number of potential networks grows. The system must be sufficiently fast to incorporate aircraft as potential gateways and reconfigurations in case of ship failure. This effort is to develop algorithms and simulate performance of internet gateways.

N89-037 TITLE: Addressing Techniques for Navy Traffic in a Multimedia Environment

CATEGORY: Engineering Development

DESCRIPTION: As the Navy converts to multimedia networking using the International Standards Organization (ISO) layered architecture, it will be necessary to develop addressing formats that support Navy traffic types without imposing a heavy burden on communication resources. Navy traffic types include a variety of point-to-point, multicast and broadcast circuits. For example, the delivery of a broadcast message using multiple point-to-point transmissions is a waste of communications resources. A common address for all intended recipients would be a better approach, given that all users have prior knowledge that they should receive the message. The purpose of this effort is to examine all Navy traffic types and operational scenarios to determine how users could be more efficiently addressed. Names must be converted to network addresses. Group addressing for multicast or conference nets should be identified. Addressing should be accomplished within the ISO model, particularly the internet protocol.

N89-038 TITLE: Analytical Tools for Communication Support Systems

CATEGORY: Engineering Development

DESCRIPTION: The communication Support System is a vital part of the Navy's Command and Control System in that it provides message, voice and data communications among platforms, sites, and warfare systems. A related effort which will impact the Communication Support System in the future is the Unified Network Technology Program. Unified Network Technology has as its objectives increased survivability of naval tactical communications through rapid data link reconfiguration and increased communication efficiency via dynamic multi-network management. The multi-network environment includes High Frequency radio, line-of-sight radio, satellite links and intra-site local area networks. Traffic includes both digital data and voice. The development of analytical tools such as computer simulation are required in order to support improvements in network management algorithms and the extrapolation test results to larger networks.

N89-039 TITLE: Communications Resource Management Algorithms

CATEGORY: Advanced Development

DESCRIPTION: The normal process of establishing navy communications lines is manual and time consuming. This task is to develop techniques which will automatically set up reliable communication links. Links to be considered are High Frequency, Ultra-High Frequency, Ultra-High Frequency Line-of-Sight, and Ultra-High Frequency Satellite Communications. Setup should include frequency tuning, channel probing for quality, and

organization of links into networks. Line-of-Sight, Extended Line-of-Sight and Beyond Line-of-Sight links should be addressed. Techniques for link quality monitoring should also be investigated.

N89-040 TITLE: Data Base Management Techniques for Navy Message Addresses

CATEGORY: Engineering Development

DESCRIPTION: As the Navy transitions from fixed dedicated communication links to the dynamic management of a pool of communication links, it will be necessary to develop a computer- based phone book. User addresses must be converted to network addresses at a speed that matches the user request for service rate. The phone book must also be updated as new users enter the network. The purpose of this effort is to develop data base management systems that address the following issues: 1) Addressing Formats. Identify methods for converting names to network addresses. Names include various groups of users, single users, and broadcast users. For example, a group of users may be formed to support a common activity such that a single network address can be used in lieu of transmitting many individual user addresses. 2) Search Speed. User transmissions may be short with a need for rapid transmission. Since each user request will require a data base search for addressing, the speed of search will be critical. 3) New User Network Entry. The entry of a new user into the network must be accomplished with a minimum of network overhead. The issue is would it be more efficient to maintain a large data base of potential users such that a user needs to transmit only a short message or should the users transmit a complete network address? The new user entry must be rapid to support the transmission of time-critical data.

N89-041 TITLE: Protocol Development for Secure Voice Network Management

CATEGORY: Advanced Development

DESCRIPTION: As Navy voice circuits are transitioned from existing switching systems which are manually set up, to voice on a Local Area Network (LAN) with dial-up capabilities, it will be necessary to develop protocols and addressing for secure voice network management. Since voice and data will share the same 2.4K bps circuits, it will be necessary to develop protocols that switch between data and voice on demand. Network management for half duplex circuits should also be identified. Addressing must consider both point-to-point and conference calls. Radio Frequency media to support voice should be High Frequency, Ultra-High Frequency Line-of-Sight, and Joint Tactical Information Data System, all with repeaters and Satellite Communications circuits. This effort is to develop both addressing and network protocols for automatic management of Naval voice circuits.

N89-042 TITLE: Graphic Displays for Multimedia Network Management

CATEGORY: Advanced Development

DESCRIPTION: As Navy communication systems are integrated into a pool of resources connected via a Local Area Network and are dynamically controlled, it becomes impossible for Naval personnel to determine overall communication system status. To alleviate this problem, it will be necessary to develop network monitoring techniques and graphics displays that are useful to Naval personnel. Display information should include items such as connectivity, traffic loading on each circuit, some indication of circuit reliability, past history on each circuit, ability to detect spoofing, etc. Connectivity information presents some unique challenges in that network topology does not necessarily imply ship geographic deployment. This may cause some difficulty to ship personnel in trying to correct system failures. Areas to investigate would be the use of Navy Tactical Data System data in forming the network display or using network connectivity and network timing to imply a geographical deployment. The purpose of this effort is to identify network information that needs monitoring and to develop graphics displays that can be used for status evaluation by Navy personnel.

N89-043 TITLE: Mixed Media Loading Analysis for Local Area Networks (LAN)

CATEGORY: Advanced Development

DESCRIPTION: In order that future Navy communication system architectures have the capability to pool communication links for use by all users, it will be necessary to connect links and users via a Local Area Network. This LAN must carry mixed data types (e.g.,voice, messages, imagery data, computer data, etc.). Each user will have different delivery criteria and will place different demands on LAN performance. Different data types will tolerate different delays. This effort is to investigate various LAN and to determine performance versus mixture of Navy traffic types. In support of developing interface standards, it will be necessary to define standard traffic formats that encompass all Navy traffic types. This includes voice, data, messages and imaging data. The model must include speed of delivery, acknowledgement time, user population, reliability delivery requirements, etc.

N89-044 TITLE: Multimedia Dynamic Control Algorithms

CATEGORY: Advanced Development

DESCRIPTION: The future Navy communication system architecture will change from fixed dedicated links to a pool of links to be shared by all users. The issue is how is link selection determined on a dynamic basis? What rules should be used to select High Frequency over Ultra-High Frequency Satellite Communications? The selection criteria must consider connectivity, time delay bandwidth, traffic loading, priority, etc. The cost functions used for link selection must also be stable with platform

motion/destruction and not vulnerable to spoofing or jamming. The issue of confidence in link selection must also be addressed. Are we 90% confident that the link is 30% reliable or 30% confident that the link is 90% reliable? How should these confidence factors be used in link selections? The purpose of this effort is to develop cost function/algorithms for dynamic link selection and demonstrate performance through simulations.

N89-045 TITLE: Multimedia Management Algorithms for Long Haul Naval Traffic

CATEGORY: Exploratory Development

DESCRIPTION: Future Navy communication systems, in which users are attached to local networks and utilize internet gateways for extended coverage, will need the capability to acquire/distribute global information for long haul connectivity. The issue is how much global information must each user maintain. For example, a task force may maintain global information on its own forces but have no information on other remote task forces. Should a central location, such as a shore site, be responsible for maintaining global information with queries from the task force? Does the need to send local global data to a centralized data base consume a large percentage of communication resources? The purpose of this effort is to investigate techniques for developing, disseminating and maintaining global information sufficient to support Naval operations without a large overhead burden on communication resources.

N89-046 TITLE: Multinet Controller Hardware/Software Architecture

CATEGORY: Engineering Development

DESCRIPTION: In order to manage multimedia circuits and multiusers dynamically, it will be necessary to develop a multinet controller. The multinet controller must also include a data base of user addresses and a display capability for monitoring network status. The multinet controller will also contain the Communication Plan for circuit setup. The multinet controller will not pass actual traffic. It's function is to set up circuits based on user service requests. It must also have the capability to monitor all traffic flow and link network status. Performing these functions in real time could be a heavy processing load. The purpose of this task is to investigate hardware and software configurations for a multinet controller. Hardware should be based on commercial back plane buses such as VME, and make maximum use of existing VME- compatible processors. Software should investigate the use of real-time operating systems and must support Ada.

N89-047 TITLE: Network Protocols for UHF Multiuser Traffic

CATEGORY: Engineering Development

DESCRIPTION: Typical network protocols used in Navy Ultra-High Frequency Satellite Communications circuits are tailored to a specific user. Each link controller needs to support only one type of traffic. As the Navy transitions to an architecture in which communication links are treated as a pool of resources to be shared between all users, each link must have network protocols that can support all types of Navy traffic (voice, data, message, image, etc.). This effort is to develop network protocols that can support multiple user traffic in both point-to-point, multicast and broadcast modes. Protocols which dynamically change in response to user requests are to be considered. The emphasis is an efficient use of channel capacity and minimal time to reconfigure protocols as traffic type changes. Protocols must be tested to verify performance.

N89-048 TITLE: Computer-Aided System Engineering in Support of Multi-Warfare System Development

CATEGORY: Advanced Development

DESCRIPTION: The Space and Naval Warfare Systems Command (SPAWAR) has identified a need to apply computer-aided system engineering (CASE) tools and methodologies to support warfare architecture and systems engineering analyses. The complex interactions of multiple warfare, equipment, and platform architectures and systems requires the use of tools and methods to help keep requirements, capabilities and interfaces clearly defined and coherently connected. Further, in order to respond promptly to Navy information requirements, SPAWAR must be able to rapidly reconfigure system connectivities and parameters, have confidence that all required interfaces are matched properly, and that the connectivities and performance numbers make sense. Given the complexity of the modern battle force, a CASE tool is mandatory. Required effort will be to enter warfare mission area architectures and plans into the CASE tool and build the required battle forces. From this level, an attempt will be made to expand the tools to lower levels in direct support of the Battle Force System Engineering Plan (BFSEP), Warfare System Performance Specifications (WSPS), and the Warfare System Controlled Interface Document (WSCID). Methods to ensure configuration management, regular review and update of systems parameters and how to handle required future capabilities will be defined. Practice in exercising the CASE tool, as well as mapping a strategy for sustained use, will be required. Given the proliferation of different CASE tools with dissimilar capabilities, the last step of this effort will be to examine the ability to perform CASE tool integration across different tools and their respective data bases.

N89-049 TITLE: Distributed Real-Time Operating System With Task Migration

CATEGORY: Exploratory Development

DESCRIPTION: In a Local Area Network (LAN) connected shipboard combat system, critical tasks should be able to migrate from one central processing unit (CPU) to another CPU (via the LAN) upon CPU failure. CPUs must export critical state variables to redundant locations in order for a new CPU to take over a failing CPU's task and rapidly and accurately converge to the current state of the combat environment. Novel and innovative concepts are required for exporting real-time state variables with a concurrent requirement of avoiding redundant data base(s) corruption due to the presence of erroneous state variables from a failing CPU.

N89-050 TITLE: Analysis of the Reconfiguration of Local Area Networks (LAN)

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has selected two commercial Local Area Network (LAN) standards, IEEE 802.5 and ANSI X3T9.5 FDDI, as the protocol core of the SAFENET-I and SAFENET-II LAN standards. Both of these LANs use token-passing as an access control mechanism, both use counter-rotating rings with station bypassing. Reconfiguration following failure can involve station bypassing, cable switching or loopback. The length of time required to detect a failure, exchange data to effect reconfiguration, and restart the token is of concern to system designers with time-critical applications. Flexible evaluation tools (e.g., simulation models) are needed having the capability to fine-tune the evolving reconfiguration time as a function of the failure extent over a broad range of network sizes.

N89-051 TITLE: Shipboard Electromagnetic Emissions Management for Electronic Warfare and Communications

CATEGORY: Exploratory Development

DESCRIPTION: The management of active shipboard emissions will enhance battle forces' war-fighting capabilities through improved systems operation and reduced vulnerability to enemy attack. Emissions management should prevent the simultaneous active use of electromagnetically incompatible systems (e.g., radar and radio), optimize the use of available communications bandwidth, and prompt the transitions between the complete restriction of emissions (total EMCON) and active use of electronic warfare (EW) and/or communications equipment. Assuming that all shipboard active emissions can be enabled/disabled by netted emissions management software, an operations analysis will be used to establish criteria for automatically prioritizing conflicting requests for emission and to change priorities of those requests in queue as the situation demands. The criteria will accommodate simultaneous operations in

multiple warfare mission areas (e.g., anti-air and anti-submarine). They must be responsive to rules of engagement, levels of conflict, and conditions of readiness as determined by higher authority. Upon completion of the criteria, a flow diagram for an implementing master algorithm will be prepared. The functions in that algorithm will be partitioned by the implementing command location to minimize the load on communications and to assure that human interfaces exist to provide for command by exception.

N89-052 TITLE: Active Sonar Range Doppler Normalization for Long Continuous Wave (CW) Transmission

CATEGORY: Exploratory Development

DESCRIPTION: Good range-rate or Doppler resolution can be obtained in active sonar by using Continuous Wave (CW) transmissions. Since range-rate discrimination, especially near zero Doppler, is becoming increasingly important for future ling-range sonar systems, it is likely that these systems will make extensive use of CW waveforms. Unfortunately, CW transmissions generate high reverberation levels, and the spectral character of these is confused by source speed, surface and bottom scattering characteristics, and off-axis clutter returns entering the system through beamforming sidelobes. For CW waveforms to live up to their promise for low Doppler discrimination, a method for normalizing the reverberant background level must be found that can effectively handle this wide range of range-Doppler reverberation parameters. A rapidly converging adaptive approach which determines the range-Doppler structure over multiple passes is one possibility.

N89-053 TITLE: Characterization of Ownship Doppler and Transmission Channel Parameters by Means of Clutter Measurements

CATEGORY: Exploratory Development

DESCRIPTION: Future use of active sonar systems in the Anti-Submarine Warfare (ASW) mission places great importance upon being able to distinguish targets from clutter using range-rate discrimination. Fine resolution of range-rate differences depends on one's ability to eliminate the effect of ownship motion from the received signals. Especially at low speed, present methods of estimating ownship speed are limited, in that the percentage error is typically large compared to requirements. Even the NAVSTAR Global Positioning System can only determine platform velocity down to 0.2 knot. Measurements on the clutter returns of active sonar search pulses can potentially provide the needed information, since the majority of this clutter originates from bottom-fixed features. Thus, by measuring clutter range-rates as a function of beam pointing direction, it is possible in principle to derive a good estimate of ownship motion. Similarly, for long-range active sonar, it is important to characterize multipath parameters of the transmission channel to and from a particular target range, and again, this should be determinable from the clutter

returns. The purpose of this task would consist of developing and evaluating candidate algorithms for deriving the information described above from the clutter signals.

N89-054 TITLE: Color Display of Acoustic Data

CATEGORY: Exploratory Development

DESCRIPTION: This task would explore and evaluate more effective ways of using color cathode ray tube (CRT) display systems for enhancing the presentation of processed acoustic data to an operator. For passive acoustic signals, possible uses of color include the combined display of data processed with different parameters, such as integration time, frequency band, or processing bandwidth. For active signals, color might be used for presentation of high resolution Doppler information, comparison of autodetect clusters with raw data, and overlay of information from various parts of complex active waveform.

N89-055 TITLE: Communication and Data Base Architectures to Support Remote Ship and Shore Users

CATEGORY: Exploratory Development

DESCRIPTION: Existing land-based computer-to-computer communication systems support the use of large computer complexes by a variety of remote users. Distant users may perform data base interrogation functions and/or execute complex programs not otherwise available to them while using only minimal communications capacity and local computer resources. Similar direct access by naval shipboard or remote shore users to remote processing and data base functions could support a variety of useful functions in the logistics, surveillance, maintenance, oceanographic, and planning areas. This research and development task would develop requirements for such a capability and propose candidate computer and communication architectures to support remote query requirements for distant shore facilities and ships at sea.

N89-056 TITLE: Data Compression for Acoustic Surveillance Data

CATEGORY: Exploratory Development

DESCRIPTION: As future undersea surveillance systems evolve toward increasing use of active acoustics and multi-sensor correlation, there is a commensurate increase in the need to transmit a wide variety of acoustic surveillance data over digital networks and to store larger quantities of this information in digital form. Data compression techniques are sought to permit efficient transmission of both active and passive acoustic data (including LOFARGRAMs) over digital links of limited capacity, while retaining an ability to reconstruct the underlying sonar/acoustic scenario from the compressed digital data, without loss of detection and classification clues. Required capability of the technique includes a spectral dynamic range of 60 dB and ambiguity surface sidelobe fidelity which does not increase -30 dB sidelobes more than 1 dB. Although many

data compression techniques in all their generality have been widely studied, previous search and analysis of prior results should be reviewed to determine the degree of their applicability to the present problem.

N89-057 TITLE: <u>High Data Rate Satellite Communications</u>

CATEGORY: Exploratory Development

DESCRIPTION: The objective of this task is to perform appropriate analysis and architectural studies of alternative concepts to maximize communication rates between naval surface and shore nodes using Ultra-High-Frequency UHF satellite communications. The areas of investigation would likely include multiplexing techniques, adaptive shipboard antenna arrays, advanced modulation schemes, and optimum satellite channel bandwidth assignments. Throughput improvement of a factor of 3 or 4 is required (i.e., to rates of 100 kilobits/second or above) rather than incremental gains of a few percent. This degree of throughput improvement could have a dramatic impact upon shipboard terminal size, since one piece of equipment operating at a high data rate potentially could replace multiple pieces of equipment that operated at individually lower data rates.

N89-058 TITLE: <u>High Resolution Active Sonar Waveforms</u>

CATEGORY: Exploratory Development

DESCRIPTION: This task would focus on the development and testing of high resolution active sonar waveforms, such as Costas sequences, designed to enhance the simultaneous display of target highlights and Doppler. The effort would include a demonstration of corresponding processing algorithms for both initial detection and high resolution information extraction.

N89-059 TITLE: <u>Information Processing and Distribution for the Integrated Undersea Surveillance System</u>

CATEGORY: Exploratory Development

DESCRIPTION: The Integrated Undersea Surveillance System (IUSS) is a network of sensors and processing centers dedicated to wide area Anti-Submarine Warfare surveillance in both peace and war. The objective of this task is to develop a communications networking concept for the IUSS shore facilities viable through the entire spectrum of conflict ranging from peace to all-out conventional warfare. This would cover both communication media (e.g., communication satellites or landlines) and information handling approaches (e.g.,raw data transfer, contact reporting, packetizing, "sparsing," etc.) for local area, wide area, and global networking. Although conventional techniques are currently available to provide surveillance information to the fleet, new networking schemes are needed having the capability to effectively link all the players under stressed conditions.

NAVAL SUPPLY SYSTEMS COMMAND

N89-060 TITLE: Automated Electronic Parts Packaging and Handling System

CATEGORY: Exploratory Development

DESCRIPTION: Electronic repair parts are packaged in a number of ways, none of which are compatible with an automated parts storage and retrieval system. Therefore, the packaging does not meet the needs of a repair operation. This Phase I project is for the feasibility and preliminary design of a standard component package and an automated parts storage and retrieval system compatible with the parts package. The parts packaging must be compatible with automated parts loading equipment; bar coded for automatic reading; provide Electro-Static Discharge (ESD) protection; provide part pin orientation, placement, and protection; be easily separable into individualized packages; and be compatible with an individualized automated component storage and retrieval system. The automated parts storage and retrieval system must accept the component package; read the part on entry; reject the part on read error; store up to 25,000 parts; occupy no more than 80 cu. ft.; return the part upon command; and present the part for manual or automated equipment removal. The Phase I effort shall investigate existing equipments for applicability or extent of modification and provide a development cost analysis.

N89-061 TITLE: Liquid Cooling Vest

CATEGORY: Advanced Development

DESCRIPTION: The Navy requires a liquid cooling vest that, with minimal power, is capable of extracting significant metabolic heat (approximately 350 watts) from the torso of an individual. The vest shall operate by circulating either cool water, or a mixture of polypropylene glycol and water, through the vest and shall be ergonomically designed in order to provide freedom of movement in both the standing and seated positions. The vest will be worn in shipboard spaces where environmental temperatures are 130^{o}F dry bulb, 50% RH. The vest will be subject to radiant heat loads from metal boiler surfaces and must have a fire-retardant covering. The contractor should have the capability, either in house or through sub contract, to evaluate the performance of the designed vest against other commercially-available vests, in order to prove its superior performance. The vest should be designed with considerations for minimal coolant flow resistance to minimize the power needed to operate the vest. Vest pressure must not exceed 5 psi and the operable flow must not require more than 0.4 gpm. Appropriate insulation shall be provided to prevent the excessive absorption of environmental heat. To prevent local skin injury, the minimum coolant temperature should be specified in order to maintain chest temperature above 65^{o}F. The vest should be easily interfaced with a liquid circulator through the use of appropriate fittings. Acceptable methods of performance evaluation are through either a properly executed thermal manikin evaluation or human physiological testing.

N89-062 TITLE: Expert System for Circuit Board Assembly

CATEGORY: Exploratory Development

DESCRIPTION: Automated assembly of printed circuit boards (PCBs) has resulted in labor savings, reduction of rework costs, reduced work-in-process and improved product quality. One of the commonly used electronic assembly methods in industry is component insertion. A second automated process involves component part retrieval from a storage carousel (AS/RS) for the purpose of kitting parts necessary for subsequent automated PCB assemblies. Kitting is advantageous for small batch size--high diverse part mix assemblies; whereas, magazines are used for production-line oriented work. There are three primary considerations required for optimizing the scheduling of component insertions: (1) the assignment of components to the feeder magazines or kits (i.e., component assignment), (2) the determination of insertion sequence on the board (i.e., table tour), and (3) the determination of the retrieval sequence (i.e., magazine feeder sequence). A second set of optimal insertion sequence needs to be devised for a kitted set of component parts which would be more applicable to the Navy's Rapid Acquisition of Manufactured Parts (RAMP) Program. The purpose of this project is the development an expert system that optimizes the placement and insertion sequence of electronic part components for a circuit card assembly using kitted parts. An interface would be developed with vendor driven numeric control (NC) codes. Consideration for this system would include the type of insertion/assembly method (e.g., kitted parts use), type and size of a component part (e.g., DIP, axial, radial, straight pin, surface mount, etc.), and type of board (e.g., single or double sided, lead-through devices or surface mounted devices or both). This project should demonstrate a direct time/cost benefit to the automatic insertion/placement for a variety of components.

N89-063 TITLE: Dynamic Real-Time Radio Frequency Tag Network

CATEGORY: Advanced Development

DESCRIPTION: Radio frequency tags and readers have a given transmission distance. Movement of a tag beyond the transmission scope of the radio frequency tag reader, disrupts the communication, thus the tag and the material to which it is attached is "lost" to the system. Purpose of this project is the dynamic real-time tag and reader system which can communicate over a dynamically configurable radio frequency network in order to preserve communications regardless of the separation distance between the tag and the reader. Current radio frequency tag system costs would be reduced dramatically due to lower transmission distance requirements and lower numbers of readers to cover a given geographic area adequately. Two trips to Washington, DC, as well as one trip to the Naval Supply Center, Charleston and one trip to the Aberdeen Proving Grounds, Maryland, are required in the course of the project.

N89-064 TITLE: Radio Frequency Tag Triangulation System

CATEGORY: Advanced Development

DESCRIPTION: Current radio frequency tag systems have the ability to identify only that a tag exists in the tag reader's sphere of influence. When all tags are grouped together, no determination can be made as to where in the group a particular tag which is being queried is located. Purpose of this project is the development of a radio frequency tag reader that can triangulate on a given radio frequency tag and visually display the exact location of the requested tag. The visual display would be similar to the air traffic controller displays utilized for aircraft position monitoring, but portable. The display would show (in map format) all tags, highlighting the requested tag, including distance from the reader, direction, and directional relationship to other tags. Benefits would include the ability to locate radio frequency tags in groups without the need for time-consuming visual secondary inspection. Two trips to Washington, DC, as well as one trip to the Naval Supply Center, Charleston and one trip to the Red River Army Depot, are required in the course of the project.

N89-065 TITLE: Clothing System for Static Electricity Control

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has need for materials/clothing for the control of static electricity (SE) build-up on military personnel operating in dry-cold or dry-temperate environments while handling explosive-sensitive ordnance and SE-sensitive semiconductor equipment. This would be accomplished through provision of a fire retardant clothing system that will control the dissipation rate of electrical energy, thereby eliminating the potential dangerous static electrical discharge. At the end of Phase I, the contractor a) will be expected to propose at least two viable approaches towards development of a suitable material/clothing ensemble and grounding treatments, and b) will submit prototype materials and test data demonstrating the extent of SE control.

N89-066 TITLE: Lightweight Cold Weather Safety Boot

CATEGORY: Advanced Development

DESCRIPTION: The Navy requires a breathable, lightweight, cold weather safety boot that will enable personnel to function in wet-cold or dry-cold environments ranging from -10°F to 50°F. The boot should be similar in design (including the sole pattern) to Boots, Cold Weather, Insulated Rubber, MIL-B-41816, Type I, Class 2, but be approximately 25% lighter in weight. The toe of the boot must be capable of providing a minimum of 75 foot-pounds of impact protection and 2,500 pounds compression resistance when tested in accordance to ANSI Z41.1. A size 10R boot must provide a total clo value of not less than 1.9 and a water vapor permeability index of 0.3 to 0.4 minimum. Testing for thermal conductivity and water vapor permeability will be the responsibility of the Navy. The outsoles and

heels shall conform to MIL-S-22777 Grade A. A boot shall not absorb more than 15 percent water after being immersed in a bath of water for 24 hours. Also, no leakage shall be observed when flexed in water on the Army Natick Dynamic Footwear Flex Tester after 100,000 flexes, drying to a constant weight at 150°F and reflexed 100,000 times. The wide variety of commercially available WI/VP films, coatings and laminates should be investigated as a potential means of attaining the required water impermeability/water vapor permeability.

N89-067 TITLE: Portable Power Supply

CATEGORY: Exploratory Development

DESCRIPTION: The Navy requires a compact, rechargeable, portable power supply that is capable of delivering 5 watts at 12V DC over a 6-hour period. The power supply will be used in a portable personal cooling system where space and weight minimization are critical. Ideally, the battery should occupy a space no larger than 5.25" x 2" x 2.25" in a backpack configuration. The power supply must conform to appropriate military specifications for batteries. A companion recharger, with built-in overcharge protection, is required to operate from a ship compatible 155V AC, 60-Hz power source. The contractor should have the capability, either in-house or through subcontract, to evaluate and confirm the superior performance of the power supply against other systems. To enable the device to be economically produced and be logistically feasible for Navy use, the contractor should utilize commercially available state-of-the-art devices. Devices that have an energy density greater than nickel cadmium (16 W-hr/lb) or sealed lead acid (12 W-hr/lb) batteries should be examined. Lithium silver oxide and nickel hydrogen systems should be investigated.

NAVAL MEDICAL RESEARCH & DEVELOPMENT COMMAND

N89-068 TITLE: Preparation and Analysis of Pure Campylobacter Jejuni and Aeromonas Hydrophila Antigenic Protein Fractions

CATEGORY: Exploratory Development

DESCRIPTION: Grow liter amounts of specific Campylobacter Jejuni and Aeromonas Hydrophila bacterial strains and prepare protein fractions for immunologic analysis. The methods to be used for preparation and purification can include but need not be limited to: molecular sizing chromatography, ion exchange chromatography, differential solubility in salt solutions, and preparative gel electrophoresis. Additionally, the separation of non-denatured proteins from sonicates of these organisms by gel electrophoresis followed by Western Blot analysis with available anti-sera would be desirable.

N89-069 TITLE: Development of a Non-Toxic, Metabolizable Cryopreservative for Human Red Blood Cell Freezing

CATEGORY: Exploratory Development

DESCRIPTION: Development and testing of cryopreservatives for human red blood freezing, preservation and storage is required with the specific properties that permit immediate transfusion of post-thawed red cells into recipients without wash-out of the cryopreservative. This necessitates the use of a non-toxic cryopreservative that is metabolized or harmlessly excreted, as well as is able to retard or eliminate the osmotic uptake of fluid into the red cell that presently rapidly occurs with FDA-approved cryopreservatives if post-thaw wash-out prior to transfusion is not performed.

N89-070 TITLE: Physician's Encounter Data Management Computer

CATEGORY: Advanced Development

DESCRIPTION: A need exists to provide advanced computer and information technology to support Navy Health Care Providers at the patient's bedside and in hospital or clinic offices. A primary application lies in the use of lightweight, portable computers with requisite communications and artificial intelligence capabilities to perform a wide range of functions, including recording of medical histories, physical examinations, and progress notes; entering and reviewing clinical findings; generating correspondence; planning and scheduling and writing orders. Proposals should provide a vehicle to (1) evaluate current information technology and applications, (2) document requirements of Navy Health Care Providers, and (3) conceptualize a prototype system to meet identified requirements.

NAVAL AIR SYSTEMS COMMAND

N89-071 TITLE: Harpoon Employment Training on the Zenith-Z248

CATEGORY: Engineering Development

DESCRIPTION: The Zenith-248 (Z-248) is the DoD standard desktop computer (contract number F19630-86-D-0002). Since the Harpoon Weapon System is an integral asset in Anti-Surface Warfare, (ASW) a need exists for a trainer that simulates the concepts and performance of Harpoon employment for all the Harpoon platforms. A training tool is to be designed to take full advantage of the Z-248's Z86 architecture and state-of-the-art Harpoon simulation.

N89-072 TITLE: S-3B Viking/Harpoon Engagement Trainer

CATEGORY: Advanced Development

DESCRIPTION: The sophisticated nature of the Harpoon cruise missile requires an in-depth understanding of cruise missile concepts, over-the-horizon targeting, degradation of missile performance in a wide range of environments, and a tactical understanding of the aforementioned topics as they pertain to the S-3B Viking aircraft. A desktop computer-based trainer is to be designed and developed to address the complexities of Harpoon operations in the VS community. The trainer should take full advantage of Navy standard tactical desktop computer technologies.

N89-073 TITLE: Harpoon Captive Carry Simulator

CATEGORY: Advanced Development

DESCRIPTION: Training shapes are used to conduct simulated firings. In the case of the Harpoon cruise missile, firing commands are sent to the training missile and stored on media. A facility is needed to replay a simulated Harpoon launch from the P-3C aircraft on a desktop computer. The effort should employ a cost-effective approach for maximizing current Harpoon simulation technologies and providing the VP community with a means of reconstructing simulated Harpoon launch upon immediate return from flight.

N89-074 TITLE: A-6E Intruder/Harpoon Engagement Trainer

CATEGORY: Advanced Development

DESCRIPTION: The sophisticated nature of the Harpoon cruise missile requires an in-depth understanding of cruise missile concepts, over-the-horizon targeting, degradation of missile performance in a wide range of environments and a tactical understanding of the aforementioned topics as they pertain to the A-6E Intruder aircraft. A desktop computer-based trainer is to be designed and developed to address the complexities of Harpoon operations in the VA community. The trainer should take full advantage of Navy standard tactical desktop computer technologies.

N89-075 TITLE: Conducting Polymers

CATEGORY: Exploratory Development

DESCRIPTION: Future Naval airframes will incorporate large percentages of nonmetallic, largely resin-matrix composite materials. It is desirable that these materials be capable of at least a moderate level of electrical conductivity. Innovative development is required to investigate new polymeric materials or materials processing techniques that result in intrinsic conductivity. In addition to materials that conduct electronically, fast-ion or superionic conductors may be considered as candidates for development. Tailorable conductivity within the basic materials system, either by varying chemistry or processing, is highly

desirable from the standpoint of matching properties with other material components. In addition to conductive materials that have applications in structural components as resins for fibers, materials that may be utilized as adhesives or sealants are of interest. Proposed projects should include a strong engineering basis for evaluation and result in a tested or testable material or materials system that can be reasonably considered as applicable to Navy aircraft or missiles following advanced development and demonstration.

N89-076 TITLE: Nondestructive Evaluation of Composites

CATEGORY: Research

DESCRIPTION: Resin-matrix composite materials are sometimes subject to the formation of numerous internal voids, either highly dispersed or in local aggregates or layers. Conventional nondestructive evaluation (NDE) techniques, although generally capable of detecting porosity, often cannot evaluate the distribution of porosity or its mechanical significance. Innovative research is needed in NDE techniques that have the potential for industrial or military application in this area. In particular, consideration should be given to the detection, location, distribution and significance of void aggregates in resin-matrix composites. Mechanical and physical testing of candidate resin systems in conjunction with appropriate NDE is desirable as part of the determination of void significance. The resin systems of interest include both single- and multi-phase epoxies and bismaleimides.

N89-077 TITLE: Chaotic/Fractal Processing and Display Methods

CATEGORY: Exploratory Development

DESCRIPTION: Since the discovery of chaos there has been an increased interest in this new area of non-linear dynamical theory which has provided new analysis tools to aid in data characterization. Theorists claim that chaos is not totally random but is actually deterministic in nature or in a "chaotic" state. Researchers involved in the analysis of chaotic signals have developed tools by which measured signals can be tested and characterized as stochastic or deterministically chaotic. However, because of the dynamic nature of this technology, it is difficult to assess the extent and value of chaos research to date. The purpose of this effort is to assess the current status of chaotic/fractal research and to identify and develop those techniques with potential acoustic processing and display applications. An initial survey of the field of chaos technology should include identification of specific chaotic signal processing and potential display techniques along with simple proof-of-concept demonstrations of these techniques. A subset of these techniques should be refined and applied to the problem of broadband acoustic signal analysis and display methods with the end product being a software package that incorporates these techniques in an automated signal recognition paradigm.

N89-078 TITLE: Electromagnetic Fluxgate Sensor

CATEGORY: Advanced Development

DESCRIPTION: The Navy is in need of a highly accurate and reliable electromagnetic fluxgate sensor. Current Navy magnetic compasses and corresponding sensors are severely limited. Gyro drift requirements are expensive to maintain. Purpose of this project is the development of a fluxgate that will meet the Navy's requirements and will be 1553 data bus compatible. It should be compatible with the Standard Attitude Heading Reference System, the proposed New Technology Compass, and other fluxgate-dependent navigation systems.

N89-079 TITLE: Amphibious Air Traffic Control Direct Aircraft Identity Readout (AATC DAIR)

CATEGORY: Engineering Development

DESCRIPTION: Amphibious Air Traffic Control Direct Aircraft Identity Readout (AATC-DAIR) intrasystem data rates to and from display consoles exceed present fiber optic (FO) (SAFENET1) capabilities of four megabits per second. Purpose of the project is to consider converting AATC-DAIR consoles to SMART micro processor-controlled displays with a resulting factor of ten data rate reduction and display update enhancements. Conversion should include integration of FO circuits to preclude requirements for external box; signal data converter (SDC)-Display and SDC-Computer interface circuity. Modification would convert AATC-DAIR to a prime candidate for a local area network FO system. An additional advantage to the use of FO system interfaces is the reduction in shipboard weight requirements.

N89-080 TITLE: High-Speed Tracker Algorithms Study

CATEGORY: Advanced Development

DESCRIPTION: Design and document detailed computerized simulation methods to compare the performance of the following High-Speed Tracking Algorithms:

1. Adaptive Alpha, Beta Filters

2. Variable Alpha, Beta Filters

3. Extended Kalman Filters

The performance parameters shall include:

a. Target position and velocity accuracy and resolution

b. Tracker tenacity during target maneuvers

c. False track initiation rate (clear and noisy areas)

The study should also address advantages and disadvantages of each method for use in high-speed tracking.

N89-081 TITLE: Advanced Ceramic Cutting Tools for Titanium Alloys

CATEGORY: Advanced Development

DESCRIPTION: Titanium alloys are used extensively in Navy aircraft in both airframe and turbine engine applications. While carbides have been used for machining titanium, they are less than optimum and contain cobalt (a strategic metal) as a binder. The program objective is to reduce dependency on cobalt imports as well as reducing the cost of machining titanium. In the case of machining titanium alloys, the cutting tool behavior is governed by its solubility and reactivity with titanium. The failure mechanism is not a wear type phenomenon. The methodology for this program would be: a) investigate ceramic alternatives to carbide cutting tools, b) evaluate ceramic cutting tool limiting due to the reactivity and solubility of titanium into the cutting tools.

N89-082 TITLE: High Density Electronic Packing Concepts

CATEGORY: Exploratory Development

DESCRIPTION: The Naval Air Systems Command is interested in the development of novel concepts for packaging of high density electronics for computers and signal processors. The intent is to utilize high-speed parallel to serial conversion for the elimination of expensive high density multipin connectors that are currently used for parallel data transmission. Approaches include guided wave optics, free space optics and/or superconductor devices and transmission lines. All proposed concepts should have the potential of meeting the severe aircraft environment.

N89-083 TITLE: Novel High Torque DC Motors

CATEGORY: Exploratory Development

DESCRIPTION: The Naval Air System is interested in the design and development of novel DC motor concepts. The motor should be capable of developing high torque and horsepower for driving aircraft and missile control surfaces. Very high efficiency and minimum weight and volume are essential, as is operation in the severe aircraft environment. Novel materials (e.g., rare earth magnetics, superconductors and conductive polymers, as well as composite casings) are of particular interest, as is innovative design.

NAVAL SEA SYSTEMS COMMAND

N89-084 TITLE: Ship Manning Requirements Planning Knowledge Based System

CATEGORY: Advanced Development

DESCRIPTION: Officer manpower requirements are calculated for each new ship and submarine design, and for each upgrade. In addition, feasibility studies are conducted on an iterative basis, as requested. Each year, ship manning studies must be updated, based on the ship Required Operations Capabilities/Projected Operational Environment (ROC/POE) Instruction. Planning requirements for ship manning is a complex task, but is governed by a fairly clear set of documented rules. Knowledge-based systems (software packages) can be used to automate and replace the decision making and planning processes traditionally done by highly trained personnel in narrow fields of expertise. The objective of this project is to automate the ship manning requirements planning process, based on ship Required Operations Capabilities/Projected Operational Environment (ROC/POE) Instructions and other guidance. The expert system shall be developed using Guru and must run on a VAX VMS operating system. Phase I should yield a prototype expert system to perform early officer manning estimates. Phase II is expected to fully automate ship manning requirements planning functions.

N89-085 TITLE: Transient Acoustic Analysis

CATEGORY: Advanced Development

DESCRIPTION: Improved methods are needed for separation and identification of short duration noise sources that occur simultaneously or near simultaneously. Sources include broad-band, narrowband, and combinations of broadband and narrow-band noise, with different sources located at varying distances from each other. Proposals should address innovative methods for analyzing acoustic data to process, separate, and identify short duration events rapidly and efficiently.

N89-086 TITLE: Fiber Reinforcement Ceramic Coatings

CATEGORY: Advanced Development

DESCRIPTION: The problem encountered in the application of ceramic thermal barrier coatings to gas turbine airfoils and diesel engine components is coating spallation. A major factor in this coating spallation is the inability of the coating to withstand the range of mechanical and thermally induced stresses caused by changes in engine power. The objective of this program is to assess the advantages of ceramic fiber and/or whisker reinforced thermal barrier coatings in providing coating integrity in these applications. Coatings with ceramic fiber and/or whisker reinforcement should be compared to coatings without reinforcement under simulated thermal cycle conditions. The project

should include fracture analysis results, coating and powder characterization, and identification of ceramic fiber and/or whisker data plasma spray parameters.

N89-087 TITLE: Shipboard Tank and Void Inspection

CATEGORY: Exploratory Development

DESCRIPTION: A major cost driver during ship availabilities is repair to ship tanks and voids. A need exists to identify required repair work inside of Navy ship tanks and enclosures while the ship is operational; that is, prior to the planned availability. Repair work is currently determined while the ship is already undergoing a planned availability and requires cleaning and gas freeing the tanks prior to any inspection. Tanks may be compensated (flooded with seawater as fuel is used or uncompensated). Inspections include identification of side, top, and bottom corrosion, failed paint systems, failed welds and seams, deteriorated piping, deteriorated electrical stuffing tubes, damaged sounding tubes, ladders, and tank level indicators. A study is required to determine alternative inspection methods that do not require cleaning and gas freeing the tanks. Methods must be capable of being accomplished by senior Navy enlisted personnel. The study should be structured towards an operational demonstration.

N89-088 TITLE: Linear Motor Current Collectors

CATEGORY: Exploratory Development

DESCRIPTION: Linear electrical motors are being considered for various Naval applications. Linear motor designs being considered include DC brush commutated machines operating in seawater. The feasibility of operating electrical current collectors in seawater must be determined and demonstrated. The current collector (brush) system will operate at sliding velocities of up to 20 meters per second and carry 10,000 amperes of electrical current for a time duration of 3 seconds. Damage to the motor commutator is critical and must be kept to a minimum. Required brush operating life must be 1000 seconds or 300 motor operations at 10,000 amperes. In addition, the brush system will be exposed to seawater on a continuous basis and the effect on overall life and performance must be determined. Since size of the brush system will have a major impact upon motor size, the brushes should operate at the highest possible current density consistent with the above requirements.

N89-089 TITLE: Magnetic Silencing

CATEGORY: Exploratory Development

DESCRIPTION: The Navy requires closed loop magnetic signature reduction systems for the numerous field generating mechanical subsystems aboard minesweepers. Each mechanical system must have dedicated signature reduction instrumentation, all of which must work in concert to reduce the total signature of the minesweeper below levels detectable by magnetic

influence mines. A total system of closed loop signature reduction instrumentation must include such elements as: (a) magnetic sensors, b) feedback and control electronics, and (c) power supplies and magnetic coils. The studies will involve the design, fabrication, and evaluation of an appropriate system, which should consist of a minimum of two three-axis signature reduction instruments working in proximity to one another.

N89-090 TITLE: Digestible Plastic Films

CATEGORY: Exploratory Development

DESCRIPTION: Develop a substitute material for conventional plastic trash can liners that, when shredded, or otherwise reduced in particle size, poses no health threat to marine life if ingested. Ingestion of plastic wastes in the ocean has been attributed as a major cause of death to sea turtles, marine birds, fish, and marine mammals. The substitute material must retain the desirable properties of polyethylene trash bags (tensile strength, wet strength, bacterial barrier, etc.) for at least two weeks after it is used. Other applications for this product are possible. The product of this research effort shall be a prototype plastic film and test results report.

N89-091 TITLE: Development of Seawater Spray Nozzles for Gas Quenching

CATEGORY: Engineering Development

DESCRIPTION: There are potential Navy applications for seawater spray nozzles that can provide a continuous stream of fine droplets to cool hot exhaust gases effectively. Nozzles currently available are not capable of maintaining a fine droplet distribution over an extended period of time or under conditions of intermittent operation due to partial clogging of the orifice. The investigations should include investigation of the factors causing clogging and the development of a nonclogging design that will maintain a droplet size distribution with a Sauter mean diameter of approximately 100 microns at a nominal nozzle flow of 2 gallons per minute.

N89-092 TITLE: Cleaning of Ship Coatings

CATEGORY: Advanced Development

DESCRIPTION: Numerous environmental and safety restrictions exist regarding the removal, handling and disposal of coatings used to protect Navy ships' hull systems. Handling of antifouling coatings is of special interest. Concepts are required that have the potential for removal of ship coatings at rates in excess of 600 square feet per hour per mil of thickness; that do not damage the substrate materials; that are usable in a shipyard drydock environment; and that will not create products that are hazardous to both the environment and the personnel.

N89-093 TITLE: Computational Modeling of 3-D Unsteady Flow

CATEGORY: Research

DESCRIPTION: The highly three-dimensional (3-D) geometry of flowpaths in modern marine gas turbines causes very complex flow fields within the machine. The impact of these complex flow fields on the pressure losses and nonuniform flow losses is not well understood. This project is specifically directed at obtaining a better understanding of the flow through 2-D and 3-D sections of exhaust diffusers in advanced marine gas turbines. The contractor shall develop a user-friendly computer code for turbulent, separated and recirculated flows in conical exhaust diffusers with dump-type collector boxes. Software should be compatible with the VAX 11700 series computer preferably in VAX-VMS language.

N89-094 TITLE: Identification of Ignition Criteria for Low Vulnerability Ammunition (LOVA) Propellants

CATEGORY: Exploratory Development

DESCRIPTION: Low Vulnerability Ammunition (LOVA) gun propellants are designed to resist ignition from thermal threats, and as a result are inherently more difficult to ignite than conventional propellants. In order to overcome the ignition problems, the chemical and physical environments that enhance the ignition of these propellants must be identified. Once these criteria have been described, an igniter system and material can be designed that meet these requirements. Develop a test procedure that will isolate and identify the chemical and physical environments that improve the ignition behavior of LOVA gun propellants. With the results of the designed tests, describe an igniter material and system that will improve the ignition reliability of LOVA propellant in a gun system.

N89-095 TITLE: Integral Dielectric/Heat Sink for Electronic Devices

CATEGORY: Exploratory Development

DESCRIPTION: Electronic devices with increasing power output levels are required in every Navy weapon and platform system. Many such devices consist of a printed circuit board (PCB) bonded to a metal heat sink to remove heat from the board. There is potential for significantly improving the reliability of the device by eliminating the bond between the PCB and the heat sink. The goal of this topic is to demonstrate that a dielectric material can be fabricated with sufficient thermal conductivity to eliminate the need for a separate heat sink in the device. Concepts including monolithic materials such as aluminum nitride and/or novel composite designs should be considered. Beryllium oxide is suggested as the standard for comparison with new material concepts.

N89-096 TITLE: Reinforced Intermetallic Materials

CATEGORY: Exploratory Development

DESCRIPTION: Supersonic/hypersonic tactical missiles such as Standard Missile Upgrade are designed with fins and other external structural components that must operate at temperatures in the range of 2,000°F to 3,200°F. Few materials retain structural integrity in this temperature range. The family of intermetallics (aluminides, beryllides) hold some promise, and should benefit from fiber reinforcement that could provide structural stability at high temperatures combined with toughness during component fabrication and prelaunch handling. Proposals are sought with a demonstrated capability to fabricate intermetallic compounds, combined with an approach/work plan for demonstrating that reinforced intermetallic composites can be fabricated. Preliminary test data, sufficient to indicate the quality of the composites, should be provided to support implementation of a Phase II effort.

N89-097 TITLE: Polymer Matrix Composite Heat Sinks for Electronic Devices

CATEGORY: Exploratory Development

DESCRIPTION: The Navy is currently supporting development of a Standard Electronic Module (SEM) as part of the Standard Hardware Acquisition and Reliability Program. In order to meet new design specifications, heat sinks will be required that have a thermal expansion in the range of 2.8 ppm/°F, and a thermal conductivity of at least 250 W/M°K. These combined properties are not presently achievable in polymer matrix composites. Novel approaches are sought such as conductive polymers and/or metallic additions to the composite, which will meet these goals. The new heat sink should be amenable to standard polymer matrix processing.

N89-098 TITLE: Neural Net Software Applications

CATEGORY: Exploratory Development

DESCRIPTION: Knowledge-Based Systems are powerful software tools that can be used to solve complex problems in narrow areas of expertise. A user of a present day expert system can say he or she is 70% sure that a rule applies, but he or she cannot say that only 70% of the rule is correct. A neutral network can deal with the latter case. The neutral network implements this with a concept called "nearest neighbor classifier" of patterns, with the rules being interpreted as variations of patterns. Neural nets learn by example and by experience, and can recognize relationships between data that have no apparent correlation. Neutral network software can increase the power of knowledge- based systems by helping the system "learn" faster and with less human programming. This form of machine learning should make it much easier to develop expert systems in the future. The purpose of the project is to evaluate the level of maturity of currently available neural network software and demonstrate potential applications within the Navy where the best payback

can be expected, such as front-ending expert systems. In addition, a detailed plan of actions should be identified for the design, development and implemention of selected applications for use within the Navy. Phase II is to develop selected application packages, user assistance and documentation, and provide the necessary interfaces with existing NAVSEA information resources. The offeror must be thoroughly familiar with both expert systems and neural nets.

N89-099 TITLE: Application of Fiber-Optic Local Area Networks (LANs) to Shipboard Voice Systems

CATEGORY: Engineering Development

DESCRIPTION: Innovative concepts are sought for the development of fiber-optic Local Area Network (LAN) based shipboard voice communication systems that would have the following attributes: (a) modular growth capability; (b) all fiber-optic interfaces; (c) both tactical and administrative voice traffic capability; (d) external interface (radio) capability; (e) high circuit availability (e.g., multiple-vendor open architecture using commercial/military standards).

N89-100 TITLE: Non-Acoustic Sensor and Guidance for Underwater Vehicles

CATEGORY: Exploratory Development

DESCRIPTION: The use of sound in sensor, guidance, and control applications in underwater vehicles limits capability growth by the inherent slow speed of sound in water and the physical effects of the ocean environment on sound propagation. Capability is needed to accomplish these functions using non-acoustic means. The objective of this effort is to explore and ultimately develop non-acoustic sensor capabilities along with the associated guidance and control for application in small, high-speed underwater vehicles.

N89-101 TITLE: Acoustically Damped Torpedo Propellers

CATEGORY: Advanced Development

DESCRIPTION: Torpedo propellers operate in a nonuniform flow and are subjected to time-varying water-induced forces. The interaction of these flow induced forces upon the propeller produce noise. If the marine propeller were constructed of damped materials, with improved damping properties, the level of the noise would be reduced. Many materials with good damping properties have been investigated, but most have insufficient strength and are very difficult to machine into a propeller shape. Proposals are solicited for the construction of a simplified test propeller of a material with inherent good damping. The propeller will be approximately 9 inches in diameter and consist of four blades. The design will be supplied to the contractor. The studies should specify the material candidates along with the manufacturing technology rationale.

N89-102 TITLE: Measurement of Temperature and Pressure in an Underwater Explosion Bubble

CATEGORY: Exploratory Development

DESCRIPTION: There is currently a very strong interest in the use of metalized underwater explosives, but uncertainties exist about the timing of the reaction of the metal and the extent to which it contributes to explosive performance. The goal of this project is the development of a method that determines both the temperature and pressure of the explosive product gases as a function of time. The temperature can be expected to be as high as about 2,500^{o}K and the pressure as high as 100 kilobars. Temporal resolution of 1 msec or better is desirable.

N89-103 TITLE: Expert System Application to a Commanding Officer's Cognitive Process

CATEGORY: Advanced Development

DESCRIPTION: Through all phases of an Anti-Submarine Warfare (ASW) engagement, the Commanding Officer (CO) is burdened with critical, time-dependent decisions. Data may be scarce or nonexistent, and current actions may depend on previous actions or events for a successful mission. A requirement exists to replicate the cognitive process of a CO by an expert system. A prototype software system built upon ASW mission phases is desired for possible implementation in future combat systems.

N89-104 TITLE: Intermittent Contact Evaluation

CATEGORY: Advanced Development

DESCRIPTION: There exists a need for the capability to evaluate sporadic sonar contact over long periods of time, such as 24 or 48 hours. A difficult problem faced by the Commanding Officer is the assessment of intermittent contacts, such that a number of related contacts can be converted into solid contact on the target of interest. A prototype evaluation technique or system is desired in order to demonstrate concept feasibility.

N89-105 TITLE: Underwater Range Data Display Upgrade

CATEGORY: Engineering Development

DESCRIPTION: Present displays of real-time range tracking data are done on color CRTs using separate X, Y (plan), and Z (depth) plots. This requires the viewer to integrate the two plots mentally in order to visualize the true picture. A three-dimensional (3-D) projection system would eliminate this process, making the situation clearer and more meaningful to the viewer. Offerors shall perform a literature search to determine the state of the art and the feasibility of applying holographic projection techniques to display three-dimensional (3-D) real-time underwater range tracking data. It is envisioned that a satisfactory

holographic display of range tracking data would initially be projected in a volume no larger than 3 x 3 x 5 feet in a dimly lit room. Computer-generated symbols for ships, submarines, torpedoes, aircraft, and other tracked objects (participants) would be displayed in 3-D in various colors. Variable persistence wake tails indicating speed and direction of previous motion would be appended to chosen symbols. The deliverable report should list:

1. All entries found in the literature search.
2. The state of the art of real-time 3-D data displays using holographic projection.
3. Techniques used for projecting holographic images.
4. Present image intensity in holographic displays.
5. Interfacing of computer-driven data to holographic projection systems.
6. Feasibility and cost estimate of applying holographic projection to display range tracking data. The feasibility and cost estimate should include equipment availability, development requirements, interfacing and software development, and integration requirements.

N89-106 TITLE: Detection of Bottom Deployed Mines

CATEGORY: Engineering Development

DESCRIPTION: There is a need to determine the optimum frequencies for use in a mine detection and classification sonar system. The optimum frequency will be not only a function of the degree of resolution required, but also will be a function of the size of the mine, the range desired, the scattering strength of the mine, and the bottom conditions. The purpose of this task is to conduct an experimental evaluation using a breadboard sonar set operating at multiple frequencies and using various canister sizes as targets to determine empirically a matrix of trade-offs with respect to range, frequency, aperture, resolution, pulse length, and pulse shape. The deliverable product of this task is a final report describing the actions taken and the results, as well as a recommendation for follow-on action.

N89-107 TITLE: Technology for Development of a Mine Avoidance Submarine-Tethered Remote Operating Vehicle

CATEGORY: Engineering Development

DESCRIPTION: There is a need for a remote operating vehicle (ROV) that will operate from and forward of a submarine to ensure an essentially safe path through a mine field. The ROV will consist of a sonar transducer and hydrophone array operating at multiple frequencies in order to provide long-range search, medium-range detection, and short-range classification capabilities. The ROV will be tethered forward of the submarine at a predetermined distance to detect and classify mines and relay the information by cable to a display aboard the submarine, thereby allowing time to maneuver. The coverage of the sonar set will be 180 degrees

forward of the ship, with the capability of side-scan for 270 degrees coverage. The system will operate narrow-band for high resolution, and will provide a display of range, height-above-bottom, and three-dimensional imaging. The ROV will also be stored on the submarine when not in use. This task is to address a conceptual design. A subsequent task will be to prototype a complete system for evaluation at a Navy facility. The deliverable product of this task is a final report describing the actions taken and the results, as well as a recommendation for follow-on action.

N89-108 TITLE: Monolithic Composite Periscope Fairing

CATEGORY: Advanced Development

DESCRIPTION: Conduct an engineering feasibility study to investigate and recommend materials and compatible processes to replace existing periscope fairing assemblies with one-piece construction, water-resistant composites. The concept should be adaptable to various hydrodynamic shapes. The fabrication process shall be dimensionally controlled to eliminate final machining. The structure should demonstrate improved impact resistance and superior water absorption capabilities over and above conventional fiberglass.

N89-109 TITLE: Materials for Underwater Explosion Shock Wave Attenuation

CATEGORY: Advanced Development

DESCRIPTION: Conduct feasibility studies of using plastic materials and processes that lend themselves to the manufacture of closed-cell foams with high air volume, in the range 75% to 85%, to attenuate the shock wave produced by an underwater explosion.

N89-110 TITLE: High-Strength, Lightweight Torpedo Hulls

CATEGORY: Advanced Development

DESCRIPTION: Submarine-launched torpedoes currently use either cast or forged aluminum hull sections. Relatively thick hulls are required in order to withstand the hydrostatic forces encountered during deep-depth operations, and dynamic forces developed during shipboard testing. The thick hulls contribute significantly to the overall torpedo weight. Hull sections made of alternative materials are desired. The material must have higher strength/weight and/or stiffness/weight ratios than the existing design, and must be competitive in manufacturing costs. The hull sections must be 21 inches in external diameter and no less than 19 inches in internal diameter. Penetrations for cables, access covers, etc., are required. Nonpermanent end joints are also required to permit torpedo disassembly.

N89-111 TITLE: Encoded Acoustic Transponder

CATEGORY: Engineering Development

DESCRIPTION: The loss of practice torpedoes and the compromising of weapon systems due to their recovery by foreign governments is of concern to the Navy. Improved systems are needed to ensure location and recovery of all losses. The desired device is an end-of-run locator which would respond only to an encoded acoustic message. This would prevent unauthorized personnel from locating lost torpedoes. Such a device would be applicable to all torpedoes and potentially to other systems. A detailed definition of system requirements and development of a high-level system specification is desired during Phase I.

N89-112 TITLE: Prelaunch/Postlaunch Torpedo Communications

CATEGORY: Exploratory Development

DESCRIPTION: Innovative concepts are desired which would provide an improvement over existing submarine-to-torpedo prelaunch and postlaunch communication systems. The existing prelaunch communication mechanism is via an umbilical cable ("A-cable"). The umbilical has a large 65-pin connector that is attached to the torpedo tube breech door and a smaller connector that is attached to the torpedo with shear screws. In addition to occasional electrical short circuits when the torpedo tube is flooded, excessive time is required to complete all connections with the tube. Postlaunch operation involves: a) two-way communication via a single conductor guidance wire with seawater return; b) guidance wire payout concurrently from both shipboard and torpedo wire coils; and c) limiting of ship speed and maneuverability to avoid guidance wire fouling with either the ship's propeller or the towed array. Two solutions to these problems have been conceived but not developed:

1. Prelaunch communications via matching transformers.
2. Postlaunch communications via a short-range acoustic data link between two transponders which remain in close proximity after being deployed by the ship and torpedo.

Offerors are not limited to the above concepts and may address either the prelaunch issue, the postlaunch issue, or both. If both issues are addressed, separate proposals should be submitted.

N89-113 TITLE: Analysis of Electronic Warfare (EW) Programs to Support Mission Areas

CATEGORY: Management and Support

DESCRIPTION: The Assistant Chief of Naval Operations for Naval Warfare (OP-07) is directing the development of stand-alone Top Level Warfare Requirements (TLWRs) for Anti-Air Warfare (AAW), Anti-Submarine Warfare (ASW), Anti-Surface Warfare (ASUW), and Strike Warfare (SW). These will be followed by TLWRs for other major mission areas. As there will be no

TLWR specifically addressing Electronic Warfare (EW), the requirement exists to ensure that each Warfare TLWR includes EW architectures that effectively and efficiently interface with and provide improved combat effectiveness across all warfare areas. This study effort should focus on next-generation EW systems requirements. This effort will include work sessions with both operational and technical experts, translate this knowledge by means of multi-attribute utility analysis, relative comparison techniques, computer models, cost-benefit analysis and other decision support tools to prioritize programs and equipment that meet TLWRs and which support Program Objective Memorandum (POM)/Special Procurement Program (SPP)/Five Year Defense Program (FYDP) and other program planning efforts. The objective is to identify deficiencies in current and planned EW equipment performance and to provide recommendations for achieving required performance capabilities. Deliverables under this project shall include a listing of all EW programs prioritized by performance benefit and life-cycle cost; and cost/benefit curves depicting recommended order of procurement for specific EW equipments/capabilities.

N89-114 TITLE: Research Leading to a Low-Cost Traveling Wave Tube (TWT)

CATEGORY: Exploratory Development

DESCRIPTION: Present travelling wave tube (TWT) technology is labor intensive with high failure rates in manufacture. A second generation TWT, with a simplified design, capable of being produced with greater automation is required for expendable applications. Research would focus on demonstration and validation of designs and fabrication techniques that will lead to a second generation I/J band pulsed, low-cost, expendable TWT. Design to price goal is $2500.

N89-115 TITLE: Transportable RF Simulator for Electronic Support Measure (ESM)

CATEGORY: Engineering Development

DESCRIPTION: The Navy needs a transportable, programmable device capable of simulating a realistic electromagnetic signal environment at RF in the 2-18 GHz band for ESM system training and testing applications. The Navy is currently using a portable device known as the Training and Maintenance System (TRAMS) to train ESM operators in a simulated threat radar environment of up to 150 signals. A major drawback is that the system produces only a baseband video output with digital signal information. In order to fully test ESM receiver front ends, it would be desirable to add an radio frequency (RF) capability to the TRAMS (e.g., VCOs, synthesizer, etc.).

N89-116 TITLE: Passive Ranging Algorithm Using Electro-Optic Data

CATEGORY: Engineering Development

DESCRIPTION: An algorithm is required for passively ranging ships and other floating objects of interest using an electro-optic sensor. Many current passive electro-optic sensors do not readily provide range to objects that are being viewed. There is a requirement for a ranging algorithm that will operate on the output parameters of a scanning electro-optic system. Many of the classic ranging techniques are not applicable since they require multiple apertures, require resolution greater than that available from electro-optical systems utilizing discrete detector elements, or assume ideal conditions such as a stable platform, nonmaneuvering targets, or high signal-to-noise ratios. The contractor will 1.) compare existing passive ranging techniques or propose new techniques; 2.) analyze the most promising techniques, to include the effects of optical aberrations, detector element size and geometry, stabilization, uncertainties in the vertical reference, objects of unknown size, geometry, as well as maneuvering of both the ship platform and the viewed object; 3.) perform a computer simulation of the algorithm(s) to determine the effectiveness of the algorithm under diverse operating conditions; and 4.) prepare a computer software block diagram demonstrating an implementation methodology of the algorithm in a general-purpose computer.

N89-117 TITLE: Advanced Technology Applications for Electronic Support Measure (ESM) Receivers

CATEGORY: Advanced Development

DESCRIPTION: Current shipboard Electronic Support Measure (ESM) receivers were developed to detect conventional range tracking pulse radars. Advances in radar technology (spread spectrum, low power, very short and very long pulsewidths, frequency agility) and emitter density and electromagnetic interference (EMI) problems drive new requirements for future receiver designs. An in-depth study is required that addresses the trade-offs and affordability of various receiver architectures, considering the availability of advanced technologies such as MIMIC, GaAs, DRFM LSI modules, acosto-optic, microscan/compressive techniques, and azimuth-frequency mapping. Study shall evaluate technical risks, performance gain, EMI immunity, signal management, and cost factors. Phase II shall include the brassboard development of critical elements in the receiver architecture.

N89-118 TITLE: Research in Support of an Improved Traveling Wave Tube with Extended Shelf Life

CATEGORY: Advanced Development

DESCRIPTION: Present traveling wave tubes (TWTs) were designed for immediate use in applications requiring frequent radiation of the tube. When stored for long periods of time or when not energized regularly,

their vacuum envelopes degrade, leading to tube failure. Design/manufacturing improvements are required leading to a tube that is capable of prolonged shelf life (greater than 5 years) without the need for periodic degassing of the vacuum envelope.

N89-119 TITLE: Direction of Arrival (DOA) Pulse Sorting Antenna Array

CATEGORY: Advanced Development

DESCRIPTION: Radar pulse sorting in Electronic Support Measure (ESM) systems is often done using only frequency, pulse repetition interval, and pulse width as sorting parameters. Direction of arrival (DOA) is another signal parameter that can be used when monopulse techniques are employed to allow each pulse to be tagged with DOA. However, multipath can significantly degrade the accuracy of the measured DOA. Purpose of the project is to develop an antenna array that will provide radar pulse-to-pulse (monopulse) direction of arrival pulse sorting in a near sea surface, severe multipath environment. The array must fit into a package less than 8 inches in diameter and cover the SHF and EHF bands.

N89-120 TITLE: Tactics Development for Coordinated Usage of Onboard/Offboard Electronic Warfare (EW) Systems

CATEGORY: Exploratory Development

DESCRIPTION: Various onboard and offboard EW systems (Electronic Support Measures (ESM), AECM, DECM, and Decoys) have been developed for shipboard use in naval warfare. Generally, these systems are employed as stand-alone methods by single ships for anti-ship missile defense (ASMD) and counter-targeting (false targets, confusion, deception) purposes. Few (if any) tactics are available to warfare commanders that provide guidelines for coordinated employment of all EW assets available in multi-ship scenarios or which provide the tactical commander the most effective utilization of assets throughout each phase of the engagement. The requirement exists for a two-phased analysis that would determine technical feasibility and approach for coordinated multi-ship cooperative countermeasures. Phase I would include threat analysis (performance and vulnerabilities) and analysis of friendly-force capabilities. The objective of this phase is to identify deficiencies in current capabilities and to provide preliminary recommendations of proposed cooperative tactics. Phase II results would provide detailed recommendations for employment of coordinated tactics, including trade-off analysis of technical risk/performance and cost/schedule impacts. This study should include (but not be limited to) combination of techniques such as false target generation, cooperative "blinking," blip enhancement, AECM (ownship/multi-ship/offboard helo), DECM/Decoy Integration (DDI), Ship Automated Decoy Integration (SADI), and counter-ARM techniques.

N89-121 TITLE: Functional Recognition of Radar Signals

CATEGORY: Exploratory Development

DESCRIPTION: The Navy requires a functional radar signal recognition capability to enhance radar threat warning capabilities aboard submarines. Increasing computer capability and years of building data bases have led the Navy to providing a submarine Commanding Officer with specific emitter and platform identification to make threat/non-threat determinations. Prior to computer-based systems, Electronic Support Measure (ESM) operators were trained to identify radar emitters using a set of "thumb" rules to report the emitter type (function). This process has not been mechanized in our computer-based systems. These "thumb" rules need translation into algorithms for Navy systems so that an emitter is identified and reported by function. To meet the functional radar signal recognition requirements of the Navy, the contractor should:

1. Identify all functional recognition categories and determine the ranges of each parameter in the category.
2. Determine the impact of any parameter not measured by the system on functional recognition and identify possible solutions.
3. Define threat in terms of radar function and develop a decision tree for contact reporting.

N89-122 TITLE: Develop DataBase of Potential Electronic Warfare (EW) Non-Developmental Items

CATEGORY: Advanced Development

DESCRIPTION: A requirement exists to develop a computerized list (PC compatible) of Electronic Warfare Directorate applicable Non-Developmental Items (EWNDI) with sources, major characteristics (e.g., voltage, frequency, environmental capability), and available data (e.g., test, storage, reliability). This effort should include state-of-the-art hardware with the following as examples of EWNDI: high-voltage power supplies, thermal batteries and seawater batteries, lithium batteries, traveling wave tubes, delay lines (optical), photo diodes, transmission components, etc. The purpose of this list, whose extent is currently unknown, is for use in Government Requests for Proposals and to provide cost-effective alternatives to design and development in future contracts.

N89-123 TITLE: Quantitative Lubricating Oil Debris Monitoring and Analysis

CATEGORY: Advanced Development

DESCRIPTION: With the development of new, technically advanced gas turbine engines and high-speed diesel engines, the need to monitor critical parameters such as lubricating oil system debris is a necessity. Oil debris monitoring is now an established technique used throughout the aircraft industry to detect incipient failures of oil-wetted components in gas turbine engines. Oil-wetted components wear and fail by the removal

of material from their load bearing surfaces. Figures available for gas turbine engines state that approximately 30% of all engine failures are caused by metal particulate contamination in lubricating oil systems. Quantitative debris monitoring permits the early detection of lubricating oil system particulate contamination and impending component failures. Spectrographic oil analysis is the most widely used and accurate oil monitoring and analysis method. Because these spectrographic analyzers are large in size and very expensive, only a few laboratories have them. As a result, oil samples must be transported long distances in order to accurately monitor oil chemistry, thus limiting the timeliness of the information received. Proposals should address the development of a portable spectrographic lubricating oil analyzer that could be located conveniently onboard a ship or carried from ship to ship. Proposals should address development feasibility, design, installation, testing, and implementation, as well as contain a plan of action and milestones to complete the task.

N89-124 TITLE: MK 6 Life Raft Improvements

CATEGORY: Engineering Development

DESCRIPTION: Operational requirements of U.S. Navy Ships dictate improvements to the existing MK 6 life rafts. Life rafts, as a lifesaving device, must have extremely high reliability requirements. Current MK 6 life raft design experiences nominal inflation failures caused by inadequate containment of the life rafts to take rough treatment during transportation and stowage and inherent inflation system design shortfalls. Proposals are sought on the following:

(a) Improved methods to encapsulate the life rafts,
(b) Provide a completely reliable inflation system,
(c) Reduce cost of and improve recertification program.

Phase I will be a design study detailing the improvements. Phase II will require fabrication of a prototype for at sea testing. Although an existing life raft can be provided as a test platform and as the core around which the improvements are designed, a completely new life raft design developed as a result of this study could also be considered.

N89-125 TITLE: Shipboard Composites

CATEGORY: Exploratory Development

DESCRIPTION: The Navy currently uses machinery foundations and other ship components made of various steels which require high level of maintenance in order to control corrosion. These components also contribute to the overall weight of the ship. Modern materials such as glass-reinforced plastic (GRP) and graphite composites offer properties such as high strength-to- weight ratios and resistance to corrosion which could make them attractive alternatives to steel for use in some shipboard applications. Proposals are solicited for applications of composites to shipboard use. The proposed effort would produce a system concept

definition including a trade-off study of proposed materials and a comparison with those currently in use in order to define requirements, limitations, advantages and disadvantages of each in the marine engineering environment. Also included would be a survey of potential applications for these composites in the shipboard environment.

N89-126 TITLE: Docking Blocks Technology

CATEGORY: Engineering Development

DESCRIPTION: Docking blocks used in drydocking U.S. Navy ships are presently constructed of wood (and also, at times, steel and concrete). The blocks must be custom cut and fitted for each docking. Also, the proper wood is difficult to obtain, its properties vary widely, and its condition after extended use is difficult to judge. A dependable, cost-effective alternative to the present blocking system is needed. The Phase I effort would include identifying existing methodology and requirements and developing approaches for designing and testing alternatives. Phase II would implement the development and testing of one or more innovative blocking systems.

N89-127 TITLE: Low-Frequency Vibration and Acoustic Measurements

CATEGORY: Engineering Development

DESCRIPTION: Provide technical analysis for the development of a measurement standard for the extremely low-level frequency measurement range: 2 Hz to 10 Hz vibration, with applied acceleration to 10 g at ±1.5% uncertainty and 20 Hz to 50 Hz acoustic signals with ±0.2 dB uncertainty, in the presence of high sea-noise levels. Vibration measurements are extremely critical to ship silencing and failure prediction systems aboard submarines (such as the SSN-21) and surface ships. Isolation from unwanted vibrations is required for ship silencing, inertial navigation instruments, ultraprecision machining operations, and pointing and tracking systems. The TRIDENT SSBN 726 Class Vibration/Noise Monitoring System is an example. Systems such as this support ship silencing programs, assess the effectiveness of noise isolator designs and define acoustic noise sources in underwater weapon systems. These systems usually employ accelerometers that depend directly on calibration sources and standard accelerometers to simulate/calibrate vibration modes. The requirement is to achieve the best sensitivity and lowest uncertainties attainable. Underwater weapon system test facilities utilize acoustic transducers and hydrophones to performance test hull designs, torpedo launch tube designs and missile target simulators. They are also used in Navy range operations where submarine and weapon structure-borne and airborne noise sources are monitored for noise signature analysis and noise reduction projects. Measurements are required to reach the lowest possible levels to achieve effective noise reduction results. Transducer and hydrophone calibration is at the heart of system improvements. Current techniques and equipment are inadequate and limit program accomplishments. Improved methods and systems are needed for more accurate measurement of wider acoustic bandwidths, sound pressure,

acoustic intensity, and radiated sound power. Calibration methods and systems are nonexistent for sound intensity (sound pressure x particle velocity) transducers and reference sound sources used for sound power comparison measurements.

N89-128 TITLE: Data Base Architecture for Battle Force Tactical Training

CATEGORY: Advanced Development

DESCRIPTION: The ability to generate an accurate and plausible scenario for Battle Force tactical training is dependent on the quality and quantity of data from which to select. There are numerous data bases in use today that support the unique requirements of individual training systems. To fully support Battle Force tactical training, a scenario author should have a means to access all of these existing data bases. Since these data bases are in different programming languages, in different levels of detail and serve different purposes, a means to assimilate, translate and correlate them is required. This requirement is to design an architecture that will support combining and collating the variety of data currently available. This architecture should also permit addition of new data as it becomes available. The architecture should utilize a higher order language (HOL) and commercially available computers and peripherals.

NAVAL SURFACE WEAPONS CENTER/WHITE OAK LABORATORY

N89-129 TITLE: Biodegradation of Heavy Hydrocarbons

CATEGORY: Exploratory Development

DESCRIPTION: Some eight bacteria have been isolated which utilize asphalt-20 as a substrate. The interaction has been studied. It appears that the interaction with the substrate is complex; it involves the production of a surfactant and possibly an enzyme. The thrust of this topic is twofold: the production of the surfactant should be enhanced and the possible enzymatic interaction clarified.

N89-130 TITLE: Laser Optical Detection of Dynamic In-Plane Mechanical Displacements

CATEGORY: Exploratory Development

DESCRIPTION: Conventional optical interferometry has been shown to be suitable for the detection of the out-of-plane displacement of ultrasonic waves propagating in solids. In thin plates the in-plane displacements characterize the modes bearing useful information on the elastic stiffness properties. Proposals are sought for optical techniques and fiber-optical devices for detection of such displacements in carbon and metallic composites. Considerations should be given to the effects of material

surface conditions (e.g., highly absorbing, specularly reflecting, diffusely scattering), bandwidth, and signal-to-noise problems associated with measuring small displacements in a non-ideal environment.

N89-131 TITLE: Shock-Resistant Circuit Breakers

CATEGORY: Engineering Development

DESCRIPTION: Circuit Breakers with improved resistance to high impact shock are of interest for use in 120 volt, 50 ampere (max) circuits. The shock environment is a broad spectrum of frequencies. Variants of design and/or new concepts leading to improved performance are sought. Technologies may include conventional designs augmented by magnetic, shape memory alloy, spring force, mechanical, or other components. A successful device will preclude unintended opening of the breaker due to shock without inhibiting normal actuation of the breaker. Simplicity of concept is preferred. The Naval Surface Warfare Center (NSWC) will perform shock tests on prototype devices at no charge to the successful proposers.

N89-132 TITLE: Synthesis and Characterization of High Purity Explosive Compounds

CATEGORY: Advanced Development

DESCRIPTION: A need exists for a supply of individual samples of a wide range of nitrodiphenylamino-N-nitroso compounds of optimal purity and of detailed structures characterization by chromatographic behavior (HPLC, g.c.), nuclear magnetic resonance spectroscopy (^{1}H, ^{13}C and ^{15}N), FTIR high resolution, mass spectrometry and UV-vis spectra. Specifically, mono, di, tri and tetranitrodiphenylamine-N-nitroso compounds are desired. Standardized procedures should be established for regio-selective nitration of diphenylamine and optimal conditions for N-nitrosation of nitrated diphenylamine samples. Longer term goals will focus on the course and kinetics of thermal decomposition of representative members of the mono, di, tri, and tetranitrodiphenyl amine-N-nitroso derivatives. Another desirable goal is the synthesis of ^{13}C enriched analogs of several of the key compounds.

N89-133 TITLE: Non-Carbon Based Energetic Systems

CATEGORY: Research

DESCRIPTION: The overall objective of this proposed project will be to provide the basic knowledge and understanding required to achieve high energy-density performance combined with a high degree of insensitivity in new non-carbon based energetic material systems. The object of this project is to devise a method of estimating heats of formation for organic compounds containing boron, nitrogen, phosphorus, fluorine, oxygen and/or hydrogen. The end result of the project should include or make possible the derivation of bond energies for single or multiple bonds between the aforementioned elements. The effort may include, but is not limited to,

the compilation of heats of formation in the scientific literature and the calorimetric determination of heats of formation of model borazine and phosphazene compounds.

N89-134 TITLE: Evaluation of X-ray Microtomography for Energetic Materials Characterization

CATEGORY: Research

DESCRIPTION: Recent progress in three-dimensional X-ray microtomography (e.g., Science 237, 1439, 18 Sept. 1987) suggests that the technique holds considerable promise for the characterization of explosives and solid propellants in terms of filler particle size distributions, size distributions of voids produced during manufacture or service life, mixing inhomogeneities and particle composition. The proposed evaluation should try to establish the capabilities of this technique with both the synchrotron and the laboratory X-rays sources for particle size distribution measurement (resolution and accuracy), for particle and homogeneity mapping, for particle composition determination and for void sizing and mapping. Actual demonstration of capabilities on inert propellant or explosive simulants is highly desirable. (Inert simulants can be supplied by the Naval Surface Warfare Center (NSWC).

N89-135 TITLE: Radiation Transport Codes for Mini-Supercomputers

CATEGORY: Exploratory Development

DESCRIPTION: Radiation transport programs are presently computer limited, for example, in predicting fields from 100 weapons stored aboard an aircraft carrier, or in transporting a particle beam through the atmosphere and predicting its reactions with a missile structure. As a result, the complexity of the physical model and the number of different situations studied fall short of what is needed. Radiation transport physics lends itself to efficient modeling on parallel processor machines. The desired result is the statistical combination of many independent events, and locating the events in three dimensions (four if time-dependent), and it can benefit greatly from the fast attached processors. Therefore, programs designed for these machines will find immediate use in solving radiation transport problems. Computer programs that predict weapon nuclear radiation amounts and their effects on shipboard personnel or systems are needed. These codes should make use of the new parallel processors such as Digital's Polestar or Weitek's XL-8000.

N89-136 TITLE: Development of Bulk-Density Al_2O_3 Thin Films

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has a need in a variety of applications to fabricate thin Al_2O_3 films which have the density of the bulk material (3.97 gm/cm^3) and are uniform in thickness. A request for proposals is made for the development of a technique for which a thin film can be produced having thicknesses between 100 and 1000 nm. Films of this type

shall be manufactured and delivered to the Naval Surface Warfare Center (NSWC). The linear thickness of each film shall also be provided. Film densities will be verified at NSWC. Substrate materials should consist of low atomic number elements, preferably carbon or silicon.

N89-137 TITLE: Non-Lethal Anti-Swimmer System

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists for the design, development and demonstration of a non-lethal anti-swimmer device/weapon capable of deterring a casual underwater swimmer from entering an area of restricted water. Since the device would be used against a swimmer during peacetime and possibly in a foreign harbor, the device can render only temporary discomfort, causing the swimmer to surface and to promptly leave the restricted area. The device would not cause any permanent or temporary damage to the swimmer. The device must be effective to greater than 200 yards and portable, less than 50 pounds.

N89-138 TITLE: Holographic Optical Element Fabrication

CATEGORY: Exploratory Development

DESCRIPTION: Holographic optical elements provide a means of reducing the size and weight of optical signal processing systems for use in such applications as missile seekers and other airborne weapon systems. Simple, economical, integrated, computer-aided design and fabrication systems are required to allow practical experimentation and development of widespread application of holographic optical elements as replacements for conventional optical elements.

N89-139 TITLE: Shock Hardened On-Board Data Acquisition System

CATEGORY: Exploratory Development

DESCRIPTION: Develop a compact, rugged, 12-channel minimum, on-board digital data acquisition system, capable of measuring and recording shock experiences associated with weapon delivery and use. Shock experiences to be measured will include: bomb rack ejection, parachute or fin opening, water entry, bottom impact, target impact, counter mine, etc. The system shall be self-contained, packaged as small as possible, and may be of modular design. Each module must contain at least four data channels and typically be 2-1/2 inches maximum dimension. The system shall be powered from internal batteries, and capable of one month of data storage. The system shall measure and store data of appropriate amplitude from analog devices at programmable sampling rates up to 10 kHz data for 400 mS or 200 Hz data of equivalent duration. The data shall consist of 12 bit words of A/D data. Each data channel shall have separate triggering criteria which are software selectable and include such parameters as threshold level, filtered level, and integrated record level. Elapsed time to enable criteria and capture of reference baseline (pre-trigger data capture) shall also be provided. The system shall survive and operate after

exposure (25 or more times) to all pre-test test, and post-test environments (vibration, shock, temperature, humidity, pressure) associated with its use. Pre-test setup and post-test data retrieval shall be compatible with an IBM PC-AT or equivalent computer. Design considerations shall include possible expansion/use of this system as an on-board vibration and temperature digital data acquisition system.

N89-140 TITLE: Maneuvering Re-entry Body Packaging and Synthesis Computer Program

CATEGORY: Exploratory Development

DESCRIPTION: Future missions of the Navy's Submarine Launched Ballistic Missiles may require the development of new maneuvering re-entry bodies. The required aerodynamic performance is a major factor in determining the external shape of the body. Both size and shape of the body are determined in part by the internal components that must be packaged within the body. A computer program is desired that will aid in developing the size and shape of a maneuvering re-entry body for specified required performance and specified internal components to be packaged. It is desired to determine the optimized size and shape for one of several pertinent criteria.

N89-141 TITLE: Software Reliability Indicators in the Requirements and Design Phase

CATEGORY: Advanced Development

DESCRIPTION: This task will involve the investigation of software metrics and indicators of software reliability that can be applied in the early stages of a program's development. Specifically targeted is the Requirements and Design Phase. The task will involve investigating proposed approaches in the literature, developing new approaches or modifying existing ones for application in a software environment that develops both real-time fire control system software, and supporting general- purpose software such as trajectory simulations. The task will also entail developing a PC-based implementation of the tool and the demonstration of the use of that tool.

N89-142 TITLE: Improved Computer-Aided Software Engineering Technology for Embedded Computer Systems

CATEGORY: Advanced Development

DESCRIPTION: Even though today's Computer-Aided Software Engineering (CASE) products have brought some improvements to the software development process, they have deficiencies which limit their effectiveness. Some of these deficiencies are: poor user interface, documentation inadequacies, methodology constraints, and administration difficulties. Innovative ideas that could alleviate these deficiencies are requested. Proposals must identify the deficiencies to be addressed, supply supporting rationale, and provide a plan capable of producing strong results

indicating that such deficiencies can be resolved. Proposer must demonstrate experience in manufacturing CASE tools and developing real-time embedded software

N89-143 TITLE: Infrared Radiometry of Dynamic Targets

CATEGORY: Exploratory Development

DESCRIPTION: Respondents should propose a task to design and develop radiometers to measure the infrared signature of test targets. The Navy has a continuing problem in verifying the infrared signature of test targets moving at speeds corresponding to Mach numbers from 0.5 to 4.0. These test targets include missile, towed bodies, drones, and aircraft. Often the targets are augmented with directionally dependent sources and their signature is influenced by orientation, flight dynamics, range and weather. Both point and resolvable targets are important and continuous data collection is required.

N89-144 TITLE: Bistatic ASW Operations in the Year 2000

CATEGORY: Engineering Development

DESCRIPTION: This Anti-Submarine Warfare (ASW) study will consider planned developments in surface ship sonars and offboard sensors while using threat projections for the year 2000. Summary error analysis will be performed to consider the effects on bistatic detection, classification and localization for such factors as sensor placement, uncertainty, sensor insertion, time lates, target characteristics, sensor type, source usage, range, environment, and algorithm selection. The sensitivity of detection algorithms to long-range signal propagation and target scattering characteristics is of particular interest and shall be considered in detail. Study conclusions should address the overall usefulness of bistatic systems to future ASW prosecutions and may include recommendations for innovative source and sensor designs. (Clearance required to SECRET level).

N89-145 TITLE: Automated Signal Processing of Sonar Sensor Data

CATEGORY: Engineering Development

DESCRIPTION: There is an increasing need for automation of Naval ship systems in order to assist operators in complex decision-making processes. Needs are for automated expert type system, real-time signal processors of active high frequency (30-600 kHz) sonar data as related to an obstacle avoidance system and passive low to mid-frequency sonar data for application in a threat detection system. These systems must use the data from the sonar for detection, tracking and basic classification of the target in a realistic signal-to-noise ratio environment. An artificial intelligence/expert system approach with emphasis on fault tolerance to the control of the sensor processor and a low false alarm rate are primary concerns. Also a high reliability is required with a high Mean Time Between Failures (MTBF).

N89-146 TITLE: Fabrication of Continuously Reinforced Carbide and Boride Ceramics

CATEGORY: Exploratory Development

DESCRIPTION: Refractory ceramics, such as the carbides and borides of zirconium and hafnium, have been explored for use in high-temperature environments, such as rocket nozzles. Success has been limited due to the limited thermal stress resistance of such materials. The use of continuous fiber reinforcement has been shown to dramatically improve structural properties in brittle materials. The fabrication of continuously reinforced carbides and borides with chemical vapor infiltration (CVI) methods has been attempted, but has shown limited success. Metal halides produced surface coatings, but little in-depth ceramic deposition. Innovative methods of fabricating continuously reinforced carbides and borides are desired. The method must be capable of preserving the structural integrity of the fibers, provide compositional control of the matrix, and be demonstrable for parts of one quarter inch thickness or greater. One possible approach would be the development of zirconium- and/or hafnium- based organo-metallic compounds for CVI processing of fiber preforms.

N89-147 TITLE: Polyurethane Foam Propellant Containers and Coolant Sleeves

CATEGORY: Exploratory Development

DESCRIPTION: Polyurethane foam wear reducing jackets have been used with the large caliber Navy guns since the mid-1960s. The formulation, based on Canadian Patent No. 742,908, was also used to make propellant containers with the intention of replacing the cloth charge bags. The current formulation, still based on this technology from the mid-1960s contains castor oil, a natural product whose characteristics and availability are not consistent, and 2,4 tolylene diisocyanate (TDI), a toxic reagent. Utilizing state-of-the-art polymer and materials technologies, candidate replacements for the castor oil and the TDI will be identified. Also, methodologies for imparting electrical conductivity to a level effective for static charge dissipation will be identified. Materials will be formulated and evaluated in terms of cost, processibility and physical characteristics relevant to functional performance.

N89-148. TITLE: Reaction Efficiency of Aluminum in Explosives

CATEGORY: Research

DESCRIPTION: The use of metals in explosives offers a means of increasing the available energy and hence, for some applications, the performance of the explosive. Although aluminum is used in many explosive formulations, there is very little data to indicate whether there is a preferred oxidant for aluminum that would increase the efficiency of the aluminum oxidation. The goal of this project is to generate data that will

indicate whether the efficiency of aluminum oxidation can be improved by controlling the oxidant species. The techniques used might include, but are not limited to, detonation calorimetry and cylinder tests. Oxidants to be considered should include both oxygen- and fluorine-containing species.

N89-149 TITLE: Software Intensive Systems Reverse Engineering

CATEGORY: Exploratory Development

DESCRIPTION: The innovation sought in this topic is a methodology and computer-assisted implementation of the techniques to capture the specification from actual, existing, functionally correct software-intensive systems. The capture should use all relevant, available information from all sources, such as code and documentation to perform the specification recapture. Particular attention should focus on the source language (such as CMS-2), the language that will capture the specification, the ability to forward engineering to a new language (such as Ada) and the new systems with emphasis on parallel and distributed architectures. This methodology/tool should be applicable to design as well as later life-cycle management.

N89-150 TITLE: Non-Aqueous Magnesium Battery

CATEGORY: Research

DESCRIPTION: The performance of magnesium batteries is limited by negative effects related to the presence of water. These are: (a) voltage delay caused by anodic films, and (b) parasitic reactions of magnesium with water forming hydrogen gas, thereby reducing the energy density. To eliminate these negative characteristics of aqueous batteries, it is proposed to explore the potential of water-free magnesium anode electrochemical systems, which will provide the following advantages: (a) gasless, no hydrogen formation, (b) no anodic protective coating needed (eliminates one cause of voltage delay), (c) elimination of parasitic magnesium/water reaction and anode loss, and (d) elimination of magnesium hydroxide films, which also cause voltage delay. Research aimed at eliminating magnesium battery corrosion problems is sought. Respondents should describe the electrochemistry of their approach and should perform studies or experiments to indicate the likelihood of success in a Phase II continuation.

N89-151 TITLE: Catalytic Metallo Macromolecules

CATEGORY: Research

DESCRIPTION: Several new catalytic materials, including a variety of metallo phthalocyanines, porphorins, tetrazanulenes, etc., have been developed that dramatically enhance the capacity and rate capabilities of lithium-thionyl chloride batteries. This catalytic process is not understood. The proposer should be able to synthesize a variety of inexpensive metallo macromolecules, stable and preferably insoluble in

$LiAlCl_4$-$SOCl_2$ battery electrolyte. Research to indicate the probability of one or more of these successfully improving battery performance will be conducted and reported.

N89-152 TITLE: Safety Aspects of Lithium Rechargeable Batteries Utilizing SO_2-Based Electrolytes

CATEGORY: Exploratory Development

DESCRIPTION: The Navy wishes to develop rechargeable batteries utilizing lithium anodes in the potentially high-power, high-energy, SO_2-based electrolyte. The goal of this effort is to elucidate aspects of cell performance impacting on safety during normal, nonabusive cell cycling. The proposer should define approaches to overcome safety problems and should perform or plan tests to confirm his solution.

N89-153 TITLE: Dual Band Infrared Discrimination Techniques

CATEGORY: Exploratory Development

DESCRIPTION: Shipborne infrared search and track (IRST) systems are needed to fulfill the Navy's requirements for air threat detection and designation in the short-range Anti-Air Warfare (AAW) defense scenario. The pressing technical problem in IRST development is that of automatic target declaration in the presence of sea and sky background clutter. Present IRSTs operate only in a single spectral band in either the 3-5 micrometer or 8-12 micrometer region. This effort would investigate the performance improvement to be realized by utilizing both spectral bands. Tasks to be performed include (1) an analysis of the detection capability of each band in the presence of clutter, (2) a comparison between bands of performance under various meteorological conditions, and (3) development of dual band target performance. The final product would be signal and data processing algorithms for optimal dual band IRST operation. It should be understood that the dual band algorithms must involve the most suitable sub-band in the 3-5m band in combination with the most suitable sub-band in the 8-12m band.

N89-154 TITLE: Diagrammatic Language Software Implementation Productivity Analysis

CATEGORY: Advanced Development

DESCRIPTION: The productivity advantages of using computer-aided diagrammatic vice textual language for software design has been demonstrated experimentally. A fundamental question that arises is whether or not the "direct use" of diagrammatic language in the later stages of software development would further increase productivity. By direct use is meant the automated production of executable code from design and implementation level diagrams in such a manner that the developers are not exposed to a conventional text language. The primary

data needed to resolve this question are development time, level of effort, and quality of the final, tested computer programs for diagrammatic versus textual methods.

N89-155 TITLE: Hierarchical Computer Architectures

CATEGORY: Advanced Development

DESCRIPTION: In recent years a number of special-purpose parallel computer architectures have been developed for various computer time-intensive classes of problems. Examples include array processors, associative processors and data base machines. Yet very little has been done to address the needs of a broad class of problems involving hierarchical decomposition, including tree search, dynamic programming, game theory, etc. There is a need for inexpensive parallel architectures involving hierarchical processor and memory organization at the level of hundreds to thousands of CPUs using standard bus interfaces, e.g., MULTIBUS II.

N89-156 TITLE: Fiber Optic Sonar Dome Pressure Transducer

CATEGORY: Exploratory Development

DESCRIPTION: Surface vessels require that sea water pressure in the sonar dome be monitored accurately. A fiber optic pressure sensor with a range of 0-100 psig that is accurate in all types of shipboard environments (shock, vibration, thermal) over long periods of time without recalibration and is perfectly lead insensitive (immune to cable bending effects) is required. The signal conditioner used with this sensor would also be capable of transmitting the pressure data digitally via fiber optics to remote displays located throughout the ship. System must utilize 9/125 single-mode fiber at 1300nm.

N89-157 TITLE: A Higher Order Meta Model for Systems Development

CATEGORY: Advanced Development

DESCRIPTION: The manager, faced with the task of developing a complete information system, such as a combat system or a weapons subsystem, from recognition of need to deployment, finds that the system model undergoes significant metamorphosis as it progresses through the life cycle phases. However, it is obvious that all of the specifications are about the same system and the same components (data, operations on the data, and the control placed over the operations). There is, therefore, a desire to identify more generalized abstractions that would allow the mapping of local views of the components as they progress through the life cycle. This work would examine some of the existing models used in various life cycle phases, publicized documentation standards (e.g., 2167A), and analogous models in other disciplines to formulate a "higher order" entity relationship attribute model. A model is required that captures the essence of the various models into a higher level unified form from which the others could be derived.

N89-158 TITLE: <u>Standardization of Programming and Instructions for Information System Users</u>

CATEGORY: Advanced Development

DESCRIPTION: Tools for the development of information systems, such as combat systems and their embedded subsystems, include the linguistic culture that the tool developers thought was ideal for the purpose. However, the vocabulary embedded in the tool is often foreign to the users of the tool. The advent of the Entity Relationship Attribute (ERA) model has made the structure of the culture more understandable to the end users. This still does not solve the problem of having an "alien" culture or vocabulary with which the user must deal. An ideal culture would be gleaned from examining the statements, specifications, or conversations that the user has with his/her peers about the system. Using techniques of library information storage and retrieval, the user's vocabulary can be extracted from such textual material, and the familiar culture defined. The user can then begin to define his/her systems in the very familiar and appropriate vocabulary which has been formalized in this culture. The required work involves examining the tools and techniques available for the extraction and definition of cultures and providing an appropriate approach.

N89-159 TITLE: <u>Automated Integrated Navigational System</u>

CATEGORY: Engineering Development

DESCRIPTION: There is an increasing need for automation for Naval ship systems in the area of integration of navigational sensors and devices. An artificial intelligence/expert system type of control and integration of a Correlation Velocity Log (CVL) and altimeter, Ring Laser Gyro (RLG), keel depth sensor, orientation sensors (yaw, pitch, roll), and Global Positioning System (GPS) or an equivalent update system is desired. The system must interface with a controller for navigation of an underwater vehicle in real time. Fault tolerance and reliability with a high Mean Time Between Failures (MTBF) are primary concerns.

N89-160 TITLE: <u>Artificial Intelligence Based Target Recognition</u>

CATEGORY: Exploratory Development

DESCRIPTION: Target recognition is one of the key components of an autonomous weapon system. This system is intended to remove man from the process of target acquisition and recognition. One approach to the development of a hybrid image understanding system may include one or more neural networks for feature extraction and recognition. An alternative would be a knowledge-based approach to image interpretation using semantic, context, and problem domain. These techniques, or their combinations, could greatly increase the probability of detecting features or targets from the sensory data. Emphasis should be placed on those techniques which will result in a real-time target recognition system.

N89-161 TITLE: Photodetectors for Optical Signal Processing

CATEGORY: Exploratory Development

DESCRIPTION: Ultrahigh-speed optical signal processing systems still require a photodetector such as a CCD array at the image plane to sense and record the output. This creates a bottleneck at the optical interface. Major improvements in two-dimensional output detectors are necessary in terms of spatial sampling, resolution, temporal sampling, dynamic range, geometric fidelity, and processing and storage techniques for reducing output data rates. Offerors should consider a systems approach which includes the detector array and an integrated digitizing or data transformation and buffering system.

N89-162 TITLE: Nonlinear Transforms for Optical Signal Processing

CATEGORY: Exploratory Development

DESCRIPTION: Optical systems provide true parallelism and thus great speed advantages over electronic systems in a great number of signal processing applications. Linear operations such as correlation, convolution and fast Fourier transform processing are relatively easy to implement. Many signal processing techniques required to support radar and sonar applications require nonlinear transforms, such as the log function, as part of their operation. New concepts and techniques for nonlinear optical processing are required in order to perform nonlinear transforms such as the log function in real time.

N89-163 TITLE: High Performance Modulators for Optical Signal Processing

CATEGORY: Advanced Development

DESCRIPTION: Optical signal processing allows processing of radar and sonar data in real-time. This is accomplished through the use of devices that can convert an electrical signal instantaneously into a spatial modulation of an optical signal for processing with standard Fourier optics. The most useful devices are the acousto-optic modulator, which converts data from the temporal domain to the spatial domain, and the electrically addressed spatial light modulator, which performs incoherent to coherent signal conversion. New high performance acousto-optic modulators that combine large bandwidths with high diffraction efficiencies are required. New electrically addressed spatial light modulators that provide good resolution, high contrast and high update rates are required.

NAVAL SURFACE WEAPONS CENTER/DAHLGREN LABORATORY

N89-164 TITLE: Concepts for Advanced Deep-Strike Cruise Missile Damage Assessment

CATEGORY: Exploratory Development

DESCRIPTION: Emerging capabilities for cruise missiles to attack land targets at very long ranges pose a significant damage assessment problem. Among the potential approaches to this problem are various over-the-horizon communications from the missiles, imagery techniques, and fly-out-and-look. Concepts are being sought that represent new approaches to this problem or feasible implementations of existing capabilities. Proposals should include concepts for managing the data flowing back into the Battle Group and associating this data with particular missiles, as well as the hardware that collects the data.

N89-165 TITLE: Advanced Deep-Strike Cruise Missile Autonomous Target-Scene Interpretation and Decision Making

CATEGORY: Exploratory Development

DESCRIPTION: Emerging capabilities for cruise missiles to attack land targets at very long ranges pose a targeting problem for movable or relocatable targets. Long times of flight and intelligence senescence result in a significant possibility that the desired targets will not be in the anticipated location, either within or not present in the sensor field of view. Concepts are being sought that provide a capability in the missile to assess the scene and decide what to do next. If the target is missing, the subsequent action might be to proceed to a secondary target. If the target has moved but is still in the scene, proceed to it if possible even though it may have to fly around and come back - or determine that the next target is more achievable. There could be other possibilities.

NAVAL WEAPONS SUPPORT CENTER

N89-166 TITLE: Reformulation of Reclaimed PBX Materials

CATEGORY: Exploratory Development

DESCRIPTION: Ordnance reclamation activities yield particles of plastic bonded explosives approximately 1/8 cu. in. in size and smaller. There are usually broken down into a family of explosives for use in the surface mining industry. Fillers could be added to bring their detonation velocities and pressures down to more usable values. Drilling of bore holes for explosives is a considerable cost in surface mining and if the diameter of the hole required could be reduced by using a more powerful explosive, a great savings would result. This would create a market for the thousands of pounds of explosive ingredients which are excess to the Navy's present needs. The feasibility of using existing computer programs

to calculate the theoretical pressures and velocities of various washed out PBX materials and fillers must be shown. Technological requirements for lab scale testing (to follow) must be identified.

NAVAL WEAPONS CENTER

N89-167 TITLE: Friction Welding Ceramics to Metals

CATEGORY: Exploratory Development

DESCRIPTION: Develop friction welding parameters and materials interface combinations for a variety of ceramic-to-metal friction welds. Evaluate the potential for scale up to 10 inch diameter tubular joints. Determine suitable mechanical test specimen geometries. Test methods and mechanical properties of the friction welded ceramic-to-metal combinations.

N89-168 TITLE: Low Noise Millimeter Wave Receiver

CATEGORY: Advanced Development

DESCRIPTION: The need to see through battlefield obscurants and fog are axiomatic. Man Infrared and Electro-optical imaging systems are hampered under these conditions. Imaging in the millimeter wavelengths would provide a useful adjunct to these systems when their operation is degraded due to the factors above. In passive millimeter wave imaging systems low noise receivers need to be employed. The receiver needs to fulfill the dual requirement of high contrast sensitivity and high sampling rates in order to provide near time imagery. The frequency regions of interest are 35 GHz and 94 GHz with a bandwidth of approximately 2 GHz. Performance characteristics of 3.0 dB or less double sideband noise figure, a total gain of 65 dB, and a long term gain stability better than 1 part in 4000 are required. Compactness and rugged construction are also important for measurement activities involving field testing. Possible implementations could involve cooled, cooled quasi-optical, or superconductor device technologies.

N89-169 TITLE: Superconducting Millimeter Wave Mixer

CATEGORY: Advanced Development

DESCRIPTION: Many new systems are being proposed that operate in the millimeter wave area. A major obstacle in the development of these systems is the lack of low noise components, mainly the mixers used in the front end of heterodyned receivers. Current room temperature mixers have a conversion loss of 5.5 dB or more, while cooled units (20 K) suffer a loss 2.4 dB or greater. A mixer is desired that has less than 2 dB of conversion loss or preferably conversion gain. It should be similar in size compared to standard millimeter wave mixers, should not require cooling in liquid helium, and should operate from less than 10mW of local

oscillator power. The frequency bands of interest are 35 GHz and 94 GHz. It is also desirable that the mixer be usable outside of a laboratory environment.

N89-170 TITLE: Improvements in Single-Crystal Diamond Tools

CATEGORY: Advanced Development

DESCRIPTION: Special mounted, ground and polished single crystal tools are extensively used in ultraprecision machining of optical surfaces, special mechanical components, and magnetic memory substrates. The quality of the cutting edge of the diamond tool is critical to the durability of the edge in actual use and to the quality of the resultant finished surface. By combining a tool fabrication effort with an evaluation program using the Naval Weapons Center Diamond Turning Facility, a functional evaluation of tools under actual use is possible. This solicitation requests proposals in the area of selection and crystallographic orientation of the diamond crystal and processes for finishing of the tool edge. Important parameters are the tool nose roundness accuracy, and the tool edge sharpness, as follows:

1. Tool nose radius shall be in a range from 0.030 to 0.125 inches, with a maximum departure from roundness of no more than 5 microinches;
2. The cutting edge shall be free from chips and flaws when examined at 10000X in a low scanning electron microscope.

A performance goal is that the tools to be developed shall be capable of machining high phosphorous (>12%) electroless nickel with no edge damage when observed as described in item 2., above.

N89-171 TITLE: IC Design Hardware/Software Communication Protocols

CATEGORY: Engineering Development

DESCRIPTION:

1. The vendor must identify and develop communication protocols for interfacing between currently available integrated circuit (IC) design hardware and software (sometimes referred to as an "executive system").
2. Deliverables to be (a) Report and (b) hardware/software to translate between the different protocols.

Examples of IC Design Hardware/Software:

Workstations: Daisy, Mentor, Valid
Computers: PC-AT, MicroVax (VMS), Sun
Software: Dracula, Merlyn, MP2D, Hilo, Helix
Data Formats: Calm GDS-II, CIF, Applicon, EDIF, VHDL, Gerber
File Transfer: RS-232C, IEEE 488, Ethernet, TCP/IP

Plotter Interfaces:	HP, Versatec, CalComp
Printer Interfaces:	Dot Matrix, ElectroStatic, Ink Jet, Laser
Tester Interfaces:	Sentry, GenRad, Taiketa-Raiken, Tektronix, HiLevel, Cadic

NAVAL AIR DEVELOPMENT CENTER

N89-172 TITLE: Long Range Stand-Off Miniature Surveillance System for Navy Helicopters

CATEGORY: Exploratory Development

DESCRIPTION: As a result of recent U.S. Navy involvement in the Persian Gulf, the need for a long range stand-off miniature electro-optic imaging surveillance sensor for use aboard U.S. helicopters exists. The system would operate during the day and provide real time imagery onboard the helicopter at distances outside of the threat umbrella. In response to this need a number of contractors have responded with various types of equipment and concepts. A number of systems have been flight tested by the Navy. To date none of the systems proposed by the contractors have met the Navy needs. Since different contractors were involved, using a wide variety of equipment and concepts, it is apparent that a sensor system is not available for fleet operations. Also, there were other laboratory and flight demonstrations being conducted by contractors at civilian facilities. These efforts also have failed to define a system. The objective of this study will be to identify the technical approach required to design a miniature sensor for a Navy helicopter that will provide a ground resolution of three feet or less from a slant range of 60,000 feet. The research shall be directed at investigating the latest mathematical models that can simulate performance for different ranges, aircraft operating conditions as well as atmospheric conditions. In addition the study shall investigate the latest state-of-the-art in stabilization (low-friction bearings, gyros, etc.), optics (reflective, refractive, etc.), sensors (CCD, videcon tubes, etc.) and cost. Weight and size shall be restricted to 100 lbs. and 3 cubic feet, respectively. If the study identifies a technical approach, Phase II will be undertaken to develop a miniature sensor system that can provide the required imagery.

N89-173 TITLE: Smart Part

CATEGORY: Advanced Development

DESCRIPTION: A requirement exists to develop a real time automatic system for tracking the life cycle location history of aircraft structural parts. Ideally, the structural part should contain an imbedded or adhesive-mounted small (dime-sized) source device which, when externally excited/activated, would emit an identifying signal, unique to that part, capable of being permanently recorded. Since component parts are interchanged from aircraft to aircraft, the source device should be

completely self-contained and maintenance free, preferably requiring no power requirements or external wire connections/disconnections when the structural parts are changed. When aircraft power is turned on, it should cause all the source devices, peculiar to the aircraft, to be activated and emit signals which can be recorded concurrently with time/date/ aircraft serial number information as a permanent parts location history to enable the Navy to automatically track which structural component parts flew with what aircraft.

N89-174 TITLE: Water-Borne Resin Development for Flexible Adherent Primer

CATEGORY: Exploratory Development

DESCRIPTION: Air-pollution regulations that limit the volatile organic compounds (VOC) content of paints applied to aircraft and ground support equipment have restricted the use of traditional, solvent-based materials. In particular, the current flexible primer MIL-P-85853 only has a sole-source exempt solvent version for this problem. Since exempt solvents have other related drawbacks, it is necessary to develop new paint formulations that will meet the performance requirements of the above specification using water-borne technologies. This specific effort is designed to develop a water-borne resin that can be used in the formulation of a flexible adherent primer that meets the performance requirements of MIL-P-85853.

N89-175 TITLE: Fiber Optic Aircraft/Stores Interface

CATEGORY: Exploratory Development/Advanced Development

DESCRIPTION: Fiber optic transmission media are essentially impervious to the effects of EMI and EMP. That means that they will not act as antenna's for the transmission nor for the reception of electronic interference due to electrical or electromagnetic signals in the environment. These electromagnetic signals are due to deliberate transmissions (jamming), natural electrical disturbance (lightning, static electricity, sun spot activity and the like) or nuclear generated electromagnetic pulse. This feature of the optical fiber makes it an important area of investigation for military aircraft communications data bus use. It is particularly important where the bus is exposed to the environment such as an interface to a weapon external to the aircraft fuselage. The use of composites has extended the vulnerability of wire data busses to within the aircraft. MIL-STD-1760A has set aside only two connector cavities for use by fiber optic (FO) interfacing. No work has been done to determine how a fully fiber optic interface can be developed using only two cables to perform those functions required by a MIL-STD-1760 interface. The standard establishes the requirements for multiple functions to occur concurrently. These functions include release consent, address lines, high bandwidth lines on which both analogue and high speed digital signals may be required to exist concurrently, and interlock. An interesting problem arises if it is desired to make the fiber line capable of carrying the motor start or release pulse. This energy

currently is in the order of 100 watts for 10 milliseconds or 0.1 joules. Typically, an SMS for fighter aircraft will have nine weapons stations on the bus. This would require isolation of the optical receivers and transmitters on the bus from the high energy pulses defined above. This will require a device analogous to a radar T/R tube. Responses to this topic can take the form of 1) an analysis to arrive at a potential system configuration which will identify those items which need to be developed to make a viable FO weapons interface system or 2) identification of a single critical item for development, generating a plan for the needed research to develop that item and sufficient laboratory work to verify the approach is viable. This would be followed up in Phase II by developing hardware to be integrated into a system demonstration.

N89-176 TITLE: Critical Defect Assessment for New Composite and Hybrid Materials

CATEGORY: Research

DESCRIPTION: New composite and hybrid materials may possess unique failure characteristics for which existing mechanical analyses and NDE (Non-Destructive Evaluation) methodologies may be inappropriate. For these materials, it is necessary to establish the nature of critical defects, failure modes, and the effects of load and environment on failures. Also important will be the development of fracture toughness concepts relevant to these materials. This task will require both analytical and experimental efforts.

NAVAL UNDERWATER SYSTEMS CENTER

N89-177 TITLE: Rare-Earth Magnetostrictive Cryogenic Projector

CATEGORY: Exploratory Development

DESCRIPTION: A rare-earth magnetostrictive transducer with its driver operating at liquid nitrogen temperatures is needed as a high-power, low-frequency underwater acoustic projector. The transducer shall operate below 500 Hz with an acoustic power output exceeding 5 kW and an electroacoustic efficiency of at least 70%. A scaled-frequency prototype is considered essential to complement the design.

N89-178 TITLE: Laser Doppler Velocimeter (LDV) Measurements in Transient Impeller Flows

CATEGORY: Exploratory Development

DESCRIPTION: Most past experimental investigations of the physics of impeller flow fields have been conducted under steady state operation. Consequently, little is known about the prevailing phenomena and associated physics of the impeller flow field during transient or start-up operation. The intent of this task is to develop a back-scatter laser doppler velocimeter (LDV) technique and associated hardware required to

measure transient impeller flow fields. The radial and tangential components of the flow are to be measured simultaneously from pump start-up to a maximum speed of 1500 rpm. The axial component of the flow must also be measured, but can be obtained independent of the other two components. The LDV system is to use a fiber optic link to isolate the focusing and receiving lens from the remainder of the LDV system. Positioning of the measurement volume is to be accomplished through a suitable 3-axis traversing mechanism for the focusing lense. The measurement volume is to be traversed and provide the capability of making measurements over a 12 inch length in the radial direction.

NAVAL AIR ENGINEERING CENTER

N89-179 TITLE: Continuously Adjustable, Electrically Operated Control Valve

CATEGORY: Exploratory Development

DESCRIPTION: Current steam catapult technology uses fluidic amplification to control the launching of aircraft from carrier decks. In this method, the flow of hydraulic fluid through a small, controllable (electric-motor-driven) orifice is used to effect the flow rate of a much larger volume of fluid which controls the opening rate of a large rotary steam valve. The system is operated open loop, whereby the small, controlling, orifice opening is determined in advance of launch from essentially hand-tabulated nomographs depending upon various aircraft launch factors; and once set is held fixed throughout the launch cycle. The present approach is somewhat wasteful of ships fossil fuel stores for non-nuclear class carriers, or place minimum speed requirements on nuclear-powered vessels to assure a minimum safe level of aircraft take-off speed. It is desirable to have an electronically operated, continuously adjustable control valve to allow closed-loop operation with a suitable method of generating the thrust to safely launch 20,000 to 100,000 lb. aircraft by accessing the aircraft's real-time acceleration/velocity and steam pressure as feedback parameters. The advanced system should effect significant reductions in maximum vessel speed requirements and aircraft stress levels leading to longer service life.

N89-180 TITLE: Remote Wind Sensing

CATEGORY: Advanced Development

DESCRIPTION: Remote wind sensors such as laser doppler anemometry can be used to sense wind parameters about the ships structure. This system would be specialized test equipment used to map wind direction and velocities about a ship in various sea states with different ship headings. This equipment would be used to determine wind-over-deck (WOD) envelopes prior to actual flights to determine ship dynamic interface requirements. Note: This would promote greater safety and accuracy in performing dynamic interface tests and would not require test pilots to fly in potentially hazardous conditions. Additional uses of this system

would be in investigating and characterizing "burble" and its effects on carrier landings for use in developing better landing systems and control algorithms.

PACIFIC MISSILE TEST CENTER

N89-181 TITLE: Measurement of the Ultraviolet Signature of an Object

CATEGORY: Advanced Development

DESCRIPTION: Some anti-aircraft missiles use imaging trackers operating in the ultraviolet part of the spectrum. Low observability is required by aircraft to reduce detection range and to improve aircraft self protection. Design, study and analysis will be required in the following areas:

1. Aircraft signature characteristics in the ultraviolet, especially the effects of paint, sun angle, shape, shadows, etc.
2. Atmospheric absorption and scattering, the effects of atmosphere on target signature measurement, and methods of mathematical treatment in extrapolating measurement data to other ranges and conditions.
3. Available calibration sources for the ultraviolet and methods of performing accurate calibrations.
4. Methods of characterizing target and background signature data in the ultraviolet and presenting such data in forms useful to both humans and computers.

Determination of the degree of vulnerability of a low observable aircraft design or coating requires quantitative measurement data of ultraviolet reflections from the aircraft skin and of the background.

N89-182 TITLE: Expendable Ship Replica

CATEGORY: Advanced Development

DESCRIPTION: In-situ test and evaluation of new weapon systems, particularly smart weapons, is dependent upon the existence of accurate representation of ships to determine how the weapon responds on its final approach and attack on Navy surface ships. Old obsolete ships are currently used for this purpose. Due to the destructive power of modern weapons, Fleet training, as well as test and evaluation, have depleted these assets. In addition, these older vessels do not "look like" modern ships to smart weapons. Alternative methods for replicating a ship (or ships) at sea is needed. Large ship-shaped Metalized balloons shall be explored as a possible answer to this problem. Areas to be addressed shall include materials, electromagnetic response (high frequency to ultraviolet) of coating materials, design, fabrication, storage, inflation, deployment, repair/reuse, station keeping, stability, attachment/incorporation of simulated emitters, and propulsion potential. In conjunction with the study of the ship target as a test and evaluation

asset, the concept shall also be explored for tactical applications as a decoy type ship defense. In this regard the following areas shall be addressed in addition to those indicated above: (a) methods of very rapid deployment, and (b) implications for application to an unsophisticated attack as well as sophisticated war at sea scenarios.

N89-183 TITLE: RF Digital Phase Shifter (5-Bit)

CATEGORY: Engineering Development

DESCRIPTION: 5-Bit phase shifters exist, however, they have limitations in one or more of the following: (1) modulation rates, (2) carrier suppression, (3) bandwidth, or (4) low residual output noise. An application exists which requires a 5-bit phase shifter with the following characteristics: Freq. 5.3-6.0, 8.5-9.5. and 10.0-10.5 GHz; mod rates from 10 Hz to 20 MHz (not 50%), one TTL input, internal circuitry to provide proper element drive); carrier suppression of 30 dB (min) with translated outputs from plus or minus 5 Hz to plus or minus 625 KHz (measured relative to translated line), insertion loss 7 dB max; low residual noise output with phase shifter connected to input of RF amplifier of 45 dB gain, with phase shifter input terminated and with 20 MHz modulation applied to the phase shifter, the noise out of the amplifier of 45 dB gain, with phase shifter input terminated and with 20 MHz modulation applied to the phase shifter, the noise out of the amplifier (as measured with a power meter) shall not increase more than 0.5 dB. Device must meet MIL 3-5400 environment specification. This project is high-risk since no known manufacturer has designed such a device. It has a high potential use in a variety of countermeasures systems, and would be considered. Concept verification tests and evaluations shall be conducted as needed.

N89-184 TITLE: Altitude Measurement In High-Velocity Low-Altitude Vehicles

CATEGORY: Exploratory Development

DESCRIPTION: Develop techniques for accurately (centimeters) measuring the height above the sea surface of high velocity (greater than Mach 2.5) low altitude (less than 20 feet) vehicles. Techniques considered shall include those which require modification of the vehicle and those which can provide the altitude independent of any devices or equipment aboard the vehicle. All techniques, whether based on optics, Radio Frequency, or Acoustics will be considered. Concept verification tests and evaluations shall be conducted as needed.

NAVAL TRAINING SYSTEMS CENTER

N89-185 TITLE: Low Cost Computer Image Generator for Night Vision Simulation

CATEGORY: Exploratory Development

DESCRIPTION: Efforts are currently underway to develop low cost display systems to simulate Night Vision Goggles (NVG) for use in flight training simulators. A low cost image generator is needed to drive these displays. The Computer Image Generator (CIG) is different than the usual CIG found in simulation in that it need not be in color. Since the NVG display is monochrome, the CIG need only display monochrome. The low cost generator should be capable of displaying night vision terrain for use in flight simulation. The data base created for the low cost CIG should coordinate with an existing daylight data base. Provisions for inputs of flight parameters, data base location, and attitude are required. Since NVG viewing window can change dependent on the simulated flight, a provision for input of head attitude information must be provided. The computer system must be low cost and compatible with Naval Training System Center systems.

N89-186 TITLE: Low Cost Night Vision Goggles (NVG) for Simulation

CATEGORY: Exploratory Development

DESCRIPTION: The increased use of night vision goggles for flight has prompted the need for night vision flight training. Night vision systems used in flight have a limited field of view and do not allow for use of periphery cues when flying nap of the earth. A low cost display system that mimics operational NVG hardware for simulation training is needed. The low cost simulation NCG monochrome display should have display rates compatible with current flight simulation computer image generators and be comparable in weight when worn on the head. Field of view and viewing plan parameters should be that of operational NVGs.

NAVAL COASTAL SYSTEMS CENTER

N89-187 TITLE: Quiet Submarine Launcher Technology

CATEGORY: Exploratory Development

DESCRIPTION: This task involves the investigation and selection of the most feasible, new innovative concepts for quietly deploying countermeasure devices from submarines. Tradeoff studies shall be performed to provide the basis for the selections. In recent years, many conventional techniques such as pneumatics, springs, etc. have been investigated in an attempt to reduce the acoustic launch transient. To date, none of these techniques appear sufficiently quiet to satisfy future (year 2010) requirements. Existing countermeasure launchers employ a solid propellant gas generator to expel the 6.25-inch diameter by 106-inch

long devices. The following are examples of concepts which have not been evaluated for this application and would, therefore, be appropriate for this task: flow-assisted release, gravity and buoyant release, and electromagnetic launch. Concepts which would employ a combination of two or more techniques should also be included.

N89-188 TITLE: Underwater Cryogenic Cutter

CATEGORY: Engineering Development

DESCRIPTION: Advances in cryogenic technology have facilitated sophisticated applications in the aerospace, biomedical, and related fields. An underwater cryogenic cutter would employ a liquid nitrogen delivery system with application temperatures low enough to embrittle and sever structural materials through local build-up of thermal stress. Two configurations of interest include: (1) a completely portable system light enough to be carried by a single diver, and (2) a larger, longer-duration system using topside equipment to support two divers with cutters to depths of 60 fsw.

N89-189 TITLE: Hull Potential Measurement System for Underway Ships

CATEGORY: Engineering Development

DESCRIPTION: Corrosion potential measurements on marine structures are, at best, difficult because of transient galvanic activity associated with the very process of cleaning to bare metal. Additionally, potential fields are known to respond to fluid velocities, so that measurements taken in port may not reflect a ship's condition while underway. The purpose of this task, therefore, is to develop a portable, self-contained measurement system that can be mounted by a diver while the ship is in port and that measures electrolysis activity while the ship is underway. One system approach to be considered measures the hull potential in reference to a silver/silver-chloride immersed in the water surrounding the ship. The value obtained can be used together with known speed, salinity, and water temperature to determine whether electrolysis criteria are within acceptable limits.

NAVAL CIVIL ENGINEERING LABORATORY

N89-190 TITLE: Rapid Detection of Asbestos

CATEGORY: Exploratory Development

DESCRIPTION: This study shall focus on the development of two alternative systems that rapidly determine at the work site whether or not asbestos exists in given specimens. The alternative systems will be developed to separately detect asbestos in: (1) material specimens and (2) airborne samples. The systems shall: (a) be portable, (b) make the determination

of the presence of asbestos rapidly and reliably at the work site, (c) be simple to operate by persons with some training but without a specialized technical college degree, and (d) be safe to use.

N89-191 TITLE: Joint Sealants for Concrete Airfield Pavements

CATEGORY: Advanced Development

DESCRIPTION: This study shall focus on the development of new materials for sealing joints in new pavements as well as resealing joints in existing pavements. The materials shall be resistant to: (a) jet engine effects (temperature and blast), (b) chemical (fuel, hydraulic oil, lubricants, solvents) degradation, (c) environmental (e.g., ultraviolet, moisture, freezing/thawing) degradation, and (d) mechanical (due to movement of the adjacent pavement slabs) failures (adhesion, cohesion). The continuing poor performance of currently available sealants results in the Navy expending multi-millions of dollars annually to reseal joints.

NAVAL AIR PROPULSION CENTER

N89-192 TITLE: Aircraft Engine Mixed Flow Compressor Analysis

CATEGORY: Research/Exploratory Development

DESCRIPTION: Mixed flow compressor stages have demonstrated higher pressure ration capability than axial stages at the same efficiency levels. A mixed flow stage is more rugged than an axial stage; it also enhances the foreign object debris (FOD) tolerance. The maximum pressure rise capability of a single mixed flow stage should be characterized to determine the number of axial stages that can be replaced by this technology. Several applications, such as turboprop/turboshaft and missile engines, could benefit from reduced parts and higher pressure and efficiency levels. Research is needed to thoroughly assess mixed flow compressor capabilities to determine the maximum attainable pressure ratio, efficiency levels, surge margin and variable geometry operability range.

N89-193 TITLE: Aircraft Gas Turbine Augmenter Ignition/Blowout Characterization

CATEGORY: Exploratory Development

DESCRIPTION: Aircraft gas turbine augmenters have historically experienced difficulty igniting and maintaining stable combustion at high altitudes and low flight Mach numbers (i.e., upper left-hand corner of a flight envelope). Design modifications to improve ignition are usually based on empirical correlations or experience, and are generally ineffective in improving operability. The proposed program would analytically model the ignition process using computational fluid dynamics (i.e., solving the time dependent, compressible Navier-Stokes equations)

and develop the methodology to design and modify augmenters for high altitude combustion. The methodology should include all known effects on ignition and blowout, including the effect of upstream vitiati... and the presence of a choked nozzle downstream of the flameholder. Potential Navy payoffs will include an expansion of the upper left hand corner of the aircraft flight envelope and improved aircraft operability in this area.

N89-194 TITLE: Turbine System Design Code

CATEGORY: Exploratory Development

DESCRIPTION: This technology effort will develop the software necessary to fully analyze aircraft engine turbine component aerodynamic and heat transfer designs, to establish component performance at design point and off design. The software must be user friendly, requiring a minimum of inputs to utilize the program. The heat transfer analysis portion may be limited to the flow path portion of the turbine component but should be capable of expansion to the entire turbine system.

N89-195 TITLE: Turbulence Effects on Turbine Blade Film Cooling

CATEGORY: Exploratory Development

DESCRIPTION: High temperature gas turbine engines require efficient film cooling of turbine airfoils. Film cooling schemes designed without taking into account realistic turbine turbulence will result in ineffective cooling designs. The objective of this effort is to understand the effects of turbulence on film cooling of turbine blades by conducting a literature search to assemble existing data and conducting appropriate tests to obtain data where none exists.

N89-196 TITLE: Lightweight Turbine Blade Attachment

CATEGORY: Exploratory Development

DESCRIPTION: Increased thrust-to-weight requirements of future gas turbine engines dictate a need to reduce the weight of turbine components. One place where this can be accomplished is the turbine blade/disk attachment area. The standard type of attachment uses a high stress dove tail or fir tree arrangement. There is potential for significant weight reduction by changing this method. The objective of this program is to develop a feasible attachment concept that would still allow easy removal and replacement of blades while lowering the blade attachment weight. This, in turn, will lower the blade pull stress and allow a lighter disk design, further reducing the weight of the system.

N89-197 TITLE: Bearing Coating Development

CATEGORY: Exploratory Development

DESCRIPTION: Current rolling element bearing materials are susceptible to corrosion and debris damage. Additionally, bearing components generate considerable heat due to friction and viscous drag. The goal of this effort is to develop tenacious coating systems for high speed rolling element bearings which provide for wear/debris resistance, corrosion resistance, and improved friction characteristics for loss of lubrication tolerance. The proposed coating systems must be compatible with current MIL-L-23699 and MIL-L-85734 lubricants. The coating must also tolerate soak-back temperatures of at least 600^{O}F without degradation or reaction.

N89-198 TITLE: Roller Bearing Inspection System

CATEGORY: Exploratory Development

DESCRIPTION: Current techniques for measuring dimensional tolerances of precision roller bearings are very labor intensive and include many specialized fixtures resulting in high bearing costs for components which require 100% inspection. The goal of this effort is to develop precision non-contracting measurement techniques with high through-put capability for roller inspections. The systems developed should be applicable for a wide size range and yet maintain precision measurement throughout the range.

N89-199 TITLE: Life Prediction Of Turbine Blades by Computer Modeling

CATEGORY: Engineering Development

DESCRIPTION: Engine manufacturers use the same acceptance criteria for turbine blade quality from one engine design to the next without any knowledge as to the effect of type and size of casting flaw on life. Historically, they wait for field data on high time parts to tell them if the acceptance criteria is satisfactory to produce the life desired. But by waiting, the number of affected parts in the field increases as production continues and the cost of fixes are uncovered. This antiquated, trial and error approach to life prediction degrades and jeopardizes fleet readiness and safety. An interactive, computer aided design tool is needed to simulate the flying and engine running of turbine blades containing specific flaws and flaw sizes at various locations on the blades in question. Such an interactive software program would address life issues under various "what if" scenarios relating to blade design and casting flaw geometries, sizes and locations. The historic approach of building field data to assess the reasonableness of prior (e.g. assumed) design flaw acceptance criteria would be accomplished now through specific software designed to simulate these events in a computer. This computer simulation would be capable of testing a multitude of "what if" blade design and casting flaw scenarios, depicting outcomes, recording degradation or failure modes if any, and predicting life with certainty.

Because such simulations would be accomplished superfast in present time, a high degree of blade design and casting optimization could be accomplished in a very short time at a fraction of the cost for current trial and error methods. It would open significant opportunities on "how to" lower production and ownership costs and extend blade life.

NAVAL OCEAN SYSTEMS CENTER

N89-200 TITLE: Automated Specification of Testing for Software Systems

CATEGORY: Engineering Development

DESCRIPTION: In the development of complex computer software systems an increasingly large effort is spent in the testing system. In some Mission Critical Computer Systems, software testing may involve nearly as much time as software development. Testing of a large and complex system includes the development of the test plan, the test procedures, the tests, and the organizational support of the test team. After the tests are executed, the results are analyzed for correctness. Error reporting is recorded for appropriate action. New automated tools and techniques are needed to support the testing process. Included are test scenario and specification tools which operate in conjunction with the design and program specification tools, unit and component test tools which operate on the unit and component code and test analysis tools which automate error detection. System test and test scenario tools are needed. Specialized documentation and error reporting tools would be used to assist in the support of the test organization.

N89-201 TITLE: Grid Free, Modular Large Screen Liquid Crystal (LC) Displays With Colors

CATEGORY: Exploratory Development

DESCRIPTION:

1. Undesired grid lines exist whenever the modules (the building blocks) of a Large Screen LC Panel are abutted together. The objective is to optically mask these unwanted lines, thus making a continuous, gridless, modular panel of any size possible.
2. Fiber optic microchannel plate, currently being fabricated under U.S. Army contract for night vision application, are good candidates for this optical approach.
3. According to the manufacturer, it is quite feasible to fabricate these hollow fiber optic microchannel plates with a 10° to 15° tilt in their optical axis.
4. Superimposition of these tilted hollow fiber plates on the pixels of liquid crystal panels shall diverge the entering lights toward and above the grid lines, thus making the optical masking possible.

N89-202 TITLE: EHF Antenna Array for Surveillance Systems

CATEGORY: Exploratory Development

DESCRIPTION: New and innovative techniques are needed for implementing phased arrays for the 75-110 GHz band for surface surveillance applications. Current techniques based on conventional waveguide components, and designs, such as ferrite phase shifters, are complex and too costly for production. New approaches are needed, based on low cost components and designs, such as printed circuit techniques, that will provide low cost in production. As a proof of concept, the output of the investigation should be a laboratory model array operating from 80 to 100 GHz with electronic beam steering of at least 50° in elevation and 80° in azimuth.

N89-203 TITLE: Non-Scanning Optical Tracking System

CATEGORY: Exploratory Development

DESCRIPTION: A rapid and robust optical means of detecting and establishing ranges and bearings to multiple high-speed surface targets (ie., speedboats) is needed for deployment on conventional surface platforms for purposes of target designation and tracking. Such a system shall also be used to support automatic acquisition and plotting of navigational aids and for purposes of collision avoidance on both conventional and autonomous surface vessels and robotic vehicles. Existing laser-based time-of-flight ranging systems consist of very narrow field-of-view optical receivers operating in conjunction with laser transmitters of even narrower illumination beam-width. While high angular resolution is thus achieved, mechanical scanning (usually employing rotating mirrors) is required to gather data over extended fields-of-view. Such systems are inherently slow, fragile, and prone to calibration errors. The many laser pulse transmissions necessary to raster scan the entire scene of interest increase probability of detection by enemy sensors. Since overall scan time is relatively long, system response is insufficient for weapons directing. In addition, the 3-D data so gathered is inherently distorted by sensor platform and/or target motion over the period of acquisition, necessitating computationally intensive coordinate transformations for restoration. Performance degrades rapidly as well in the presence of atmospheric obscurants such as fog and haze. Accordingly, an innovative and robust means of gathering high resolution optical 3-D data from a scene about the region of interest is needed for use on conventional and autonomous surface platforms and robotic vehicles, with the inherent ability to discriminate against background and foreground clutter. Such a system must provide rapid updates, without swamping the signal processor with inordinate amounts of unnecessary data, and employ no mechanical scanning. Resolution must be sufficient for fire control solutions, with maximum line-of-sight range between five and ten nautical miles.

N89-204 TITLE: Cross Section Reduction of Dish Antennas

CATEGORY: Exploratory Development

DESCRIPTION: Parabolic dish antennas are used in a number of radar tracking and fire control systems, ranging from small onboard systems for missile guidance to large shipborne systems for support of long range engagements. The radar cross section of these antennas, as seen by the target being tracked, can be quite large due to the retro-reflective nature of the antenna on boresite. The objective, here, is to devise alternate dish antenna designs that can significantly reduce this problem, or even eliminate it altogether. The Phase I effort should review and evaluate selected approaches, concluding with a detailed design proposal for a Phase II demonstration.

N89-205 TITLE: Waveform Design to Defeat Intercept Receivers

CATEGORY: Exploratory Development

DESCRIPTION: Broadband, high power radar concepts are becoming more practical as the required microwave component technologies advance. Radar designers are now being asked to include, in their waveform suite, options that either preclude detection or at least deny recognition by hostile intercept receivers. But intercept receiver design is also progressing. For the current and near term state of affairs, radar engineers need a clear understanding of how these receivers work and what problems the intercept receiver designer faces as the radar parameters vary. The task then is to: (1) survey current operational intercept receiver design, with particular emphasis on intercept ID algorithms, showing clearly how changes in radar parameters would impact the receiver effectiveness; and (2), from (1) and estimates of projected ID algorithm improvements, delineate the most effective radar waveform strategies.

N89-206 TITLE: Improved Direction Finding Techniques

CATEGORY: Advanced Development

DESCRIPTION: The need for improved direction finding (DF) techniques is vital to the implementation of advanced passive radio frequency (RF) surveillance and targeting systems. Accurate direction finding techniques compatible with sensor physical implementations/envelopes within missile launchers and aircraft pylons are required to provide for spatial processing and accurate location. The desire to achieve high accuracy utilizing short baseline interferometer implementations as well as alternate advanced processing techniques are of major interest. The ability to achieve accurate DF/location is a necessary prerequisite for covert, passive targeting sensor systems. The identification of unique technologies such as optical processing techniques/schemes for enhanced signal processing techniques and sensor alignment requirements are critical to achieve the necessary performance. Concepts and approaches to achieve the desired level of performance should be performed.

N89-207 TITLE: Accurate Passive Ranging Techniques

CATEGORY: Advanced Development

DESCRIPTION: The need to accurately determine the location of threat radio frequency (RF) emitters while employing passive RF surveillance and targeting sensors is critical to successful performance of future Naval missions. Current passive RF technology provides techniques to achieve accurate angular measurements, while major improvements are required in techniques for achieving rapid and accurate range measurements. Emphasis should be placed upon methodologies and processing techniques to passively determine accurate range/location of threat RF sources. Implementations compatible with passive RF airborne sensor/platform applications should be emphasized. The technical approach should address the dynamic environment, the need for accurate determination of platform attitude, position, and associated rates, sensor processing schemes/techniques, computational algorithms, and any other significant considerations in achieving the desired performance.

N89-208 TITLE: Packaging of High Speed Optoelectronic Devices

CATEGORY: Exploratory Development

DESCRIPTION: There is currently a major effort withi[illegible] [illegible]e DoD to employ fiber optic techniques tc the feeding, distribution, re[illegible]oting and processing of high frequency antenna array signals. These applications are mainly due to the extremely high time-bandwidth products attainable with optical fibers. These fiber optic distribution and signal processing devices can potentially be used in systems operating in the millimeter wave frequency range (30 GHz), which is receiving increased emphasis for military applications. At present, the bandwidth of these fiber optic links is limited to about 20 GHz by the modulation bandwidths of the optical sources or external modulators, whichever is used, and the optical detectors. External optical modulators and detectors that use III-V semiconductor technology have theoretically attainable bandwidths approaching 100 GHz. In practice, the bandwidths of these devices are usually limited by the microwave packaging. Consequently, high-speed device packaging is an extremely important issue when dealing with frequencies exceeding 30 GHz. This task requires theoretical modeling and experimental implementation of wideband millimeter wave circuits and packaging which can be used in conjunction with high-speed optoelectronic devices.

N89-209 TITLE: High Strength Optical Fibers for Air-Deployed Data Links

CATEGORY: Exploratory Development

DESCRIPTION: The recent application of optical fibers to high-speed, air-deployed data links, has developed a need for smaller diameter fibers with very high tensile strengths. During payout, the fibers are exposed to tensile and shear loads which could lead to failure. Commercial

telecommunications fibers are buffered with a thick, polymeric jacket which, because of its large diameter and linear mass density, becomes a liability for high speed air deployment. To achieve the desired fiber characteristics, one must reduce the buffer thickness while increasing the glass fiber tensile strength. Thickness reduction of the buffer materials currently used in telecommunications fibers, leads to weaker fibers. These materials typically are uv-curable epoxy acrylates. It may be possible to sacrifice thickness if alternative polymers were developed which (1) can be applied and cured on-line during fiber draw, (2) have high adhesion, but are readily strippable, and (3) provide the same protection as epoxy acrylates at half the thickness.

DAVID TAYLOR RESEARCH & DEVELOPMENT CENTER

N89-210 TITLE: High Heat Flux Heat Exchanger

CATEGORY: Exploratory Development

DESCRIPTION: Advanced heat transfer surfaces for single phase heat exchangers which will yield significantly greater heat fluxes, (e.g., factor of 5 or more improvement over conventional surfaces) are required to decrease both unit size and cost. The performance characteristics of proposed concepts will be modeled analytically for the prediction of heat transfer capabilities. A small scale demonstration model of a water-to-air heat exchanger shall be fabricated for proof of concept.

NAVAL AIR TEST CENTER

N89-211 TITLE: Infrared Scene Generation Model

CATEGORY: Engineering Development

DESCRIPTION: Models of infrared signatures are needed to simulate infrared scenarios presented by air, ground and sea threats for the test and evaluation of aircraft weapons system infrared sensors. The modeling scheme should utilize existing Compu-Scene IV and LOWTRAN software as much as possible and should provide for a generation of redefinable infrared environments for Compu-Scene IV. This would provide the capability to rapidly change the infrared scene to simulate specific threats and different modes of operation of known threats. Once the scene is generated with the proper field of view by the Compu-Scene IV software, the LOWTRAN software should calculate the atmospheric transmission losses between the aircraft's infrared sensor and the target threat. Special consideration should be given to the fact that wide field of view sensors look both horizontally and vertically through the atmosphere thus; the slant range to the received target varies. The dependency of transmission loss on look angle should be included in the model.

N89-212 TITLE: <u>Dynamic Infrared Scene Projection</u>

CATEGORY: Engineering Development

DESCRIPTION: Ground testing of forward looking infrared (FLIR) sensors determines baseline performance and is extremely effective in minimizing costly cut-and-try flight tests. There is a need to develop a thermal projection device which can dynamically simulate a high threat infrared environment. The thermal projector should be capable of taking a video or computer generated image and present a corresponding thermal image to an aircraft FLIR sensor. The system must provide a high resolution image to wide field of view navigational FLIR's. The projector should also have a frame rate fast enough for the FLIR to perform as if the projected threat environment was continuous. The systems should be portable so that it can be positioned to accommodate different FLIR sensors on the same aircraft. The projector should present images in the 8-12 micron and 3-5 micron regions of the spectrum. A projector with a wider spectral bandwidth would be preferable for the testing of future infrared sensors which may use different wavelengths.

N89-213 TITLE: <u>Multi-Mode Range Instrumentation Radar System</u>

CATEGORY: Advanced Development

DESCRIPTION: Proposals are sought to determine the technical feasibility in developing a Multi-Mode Range Instrumentation System (MRIRS). The study should establish the system performance requirements based on the flight test support required during the development, test and evaluation phases of naval airborne electronic warfare systems. The system would be integrated with existing range instrumentation, taking advantage of those assets already available and would provide the capability to operate in the following radar modes:

- Inverse Synthetic Aperture Radar (ISAR)
- pulse doppler
- pulse compression
- frequency agility
- pulse & continuous wave radar
- complex pulse trains

The MRIRS is required to replace obsolete single purpose radars and to perform electronic warfare test measurements such as radar cross section (RCS), jammer-to-skin radar return ratio measurements, radar imaging, antenna patterns, sensitivity testing, chaff evaluation and would provide the capability to simulate modern radar threats. Phase I should provide a basic design concept. Phase II will consist of developing a prototype system in one of the electronic warfare frequency bands.

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR programs is with the Air Force Systems Command Deputy Chief of Staff for Technology and Requirements Planning. The Air Force SBIR Program Manager is Mr James R. Meeker. Inquiries of a general nature or where a problem may exist requiring the attention of the Air Force SBIR Program Manager should be addressed to:

Department of the Air Force
HQ AFSC/XTXC (SBIR Program Manager)
Andrews AFB DC 20334-5000

Under NO circumstance shall a SBIR proposal be submitted to the AF SBIR Program Manager. The potential offerors are reminded that NO additional technical information can or will be made available by the Air Force during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to the section contained within this solicitation on the procedures for obtaining DTIC data.

Five (5) copies of each Phase I proposal shall be addressed to the office designated below. Any question regarding the preparation and processing of a proposal should be initially referred to the Air Force Small and Disadvantaged Business Utilization (SADBU) specialist identified in the following.

Topic No.	Address for Proposals	AF SADBU Specialists
AF89-001 thru AF89-020	AD/PMR SBIR Program Manager Bldg 350, Rm 428 Eglin AFB FL 32542-5000	Mr Ralph Frangioni AD/BC Eglin AFB FL 32542-5000 (904) 882-2843
AF89-021 thru AF89-030	AEDC/PKP Bldg 100 Arnold AFB TN 37389-5000	Mr Edward Hale AEDC/BC Arnold AFB TN 37389-5000 (615) 454-4407
Hand delivery accepted—after calling (415) 454-6517		
AF89-031 thru AF89-035	ESD/AVP SBIR Program Manager Brown Building Hanscom AFB MA 01731-5000 01731-5000	Mr Alan Hart ESD/BC Hanscom AFB MA 01731-5000 (617) 377-4973
AF89-036 thru AF89-055	RADC/XPX SBIR Program Manager Bldg 106, Rm B-109 Griffiss AFB NY 13441-5700	Mr Richard Smith RADC/BC Griffiss AFB NY 13441-5700 (315) 330-4020

AF89-056 thru AF89-067	HQ AFESC/RDXP SBIR Program Manager Bldg 1120 Tyndall AFB FL 32403	Mr Ralph Frangioni AD/BC Eglin AFB FL 32542-5000 (904) 882-2843
AF89-068 thru AF89-081	HQ HSD/SORT SBIR Program Manager Bldg 1155, Rm 25 Brooks AFB TX 78235-5000	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-082 thru AF89-100	AFWAL/AAOP SBIR Program Manager Area B, Bldg 22, Rm S-110 Wright-Patterson AFB OH 45433-6543	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-101 thru AF89-119	AFWAL/FIOP SBIR Program Manager Area B, Bldg 45, Rm 149 Wright-Patterson AFB OH 45433-6553	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-120 thru AF89-138	AFWAL/MLK SBIR Program Manager Area B, Bldg 406, Rm 149 Wright-Patterson AFB OH 45433-6533	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-139 thru AF89-157	AFWAL/POMP SBIR Program Manager Area B, Bldg 18A, Rm A-103 Wright-Patterson AFB OH 45433-6563	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-158 thru AF89-160	ASD/AEE SBIR Program Manager Area B, Bldg 57, Bay 5 Wright-Patterson AFB OH 45433-6503	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-161	ASD/RWEE SBIR Program Manager Area B, Bldg 28, Post 246 Wright-Patterson AFB OH 45433-6503	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422

AF89-162 thru AF89-168	ASD/XRX SBIR Program Manager Area B, Bldg 11A, Rm 201 Wright-Patterson AFB OH 45433-6503	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-169	4950 TESTW/FFDA SBIR Program Manager Area B, Bldg 11A, Rm 201 Wright-Patterson AFB 45433-6503	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422
AF89-170 thru AF89-182	AFSTC/OLAB SBIR Program Manager P O Box 92960 Los Angeles AFB CA 90009-2960	Mr Charles Willett SD/BC P O Box 92960 Worldway Postal Center Los Angeles AFB CA 90009-2960

Hand delivery accepted: Bldg A2, Rm 2213-B, 2350 East El Segundo Blvd,
El Segundo CA 90245-4691

AF89-183 thru AF89-184	SAMTO/XO Bldg 8500 Vandenberg AFB CA 93437-6021	Mr Charles Willett SD/BC P O Box 92960 Worldway Postal Center Los Angeles AFB CA 90009-2960 (213) 643-2855
AF89-185 thru AF89-186	HQ AFSTC/XN SBIR Program Manager Bldg 497, Rm 222 Kirtland AFB NM 87117-6008	Mr Manuel Gonzalez AFCMD/BCW Kirkland AFB NM 87117-5023 (505) 844-3819
AF89-187 thru AF89-193	AFAL/TSTR SBIR Program Manager Bldg 8353, Rm 116B Edwards AFB CA 93523-5000	Mr James Beucherie AFFTC/BC Edwards AFB CA 93523-5320 (805) 277-2619
AF89-194 thru AF89-199	AFGL/XOP SBIR Program Manager Bldg 1107, Rm 240 Hanscom AFB MA 01731-5000	Mr Alan Hart ESD/BC Hanscom AFB MA 01731-5000 (315) 330-4020

AF89-200 thru AF89-208	AFWL/PRC SBIR Program Manager Bldg 413, Rm 139 Kirtland AFB NM 87117-6008	Mr Manuel Gonzales AFCMD/BC Kirtland AFB NM 87117-5023 (505) 844-3819
AF89-209 thru AF89-234	BMO/MYSC SBIR Program Manager Bldg 523, Rm 302 Norton AFB CA 92409-6468 92409-6468	Mr Terence Carey BMO/BC Norton AFB CA 92049-6468 (714) 382-4304
AF89-235 thru AF89-247	AFOSR/XOT SBIR Program Manager Bldg 410, Rm A-113 Bolling AFB DC 20332-5000	Ms Louise Harrison AFOSR/BC Bolling AFB DC 20332-6488 (202) 767-4943
Hand delivery accepted—after calling ahead to 767-4969		
AF89-248 thru AF89-257	AFSC/NAT SBIR Program Manager Bldg 39, Area B Wright-Patterson AFB OH 45433-6503	Mr George Laudenslayer ASD/BC Wright-Patterson AFB OH 45433-6503 (513) 255-5422

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AF89-018	Miniaturization of Signal Processing Components for Guided Interceptors
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AF89-020	Plastic Extrusions for Military Container Design

Arnold Engineering Development Center, Arnold AFB TN

AF89-021	Aerospace Ground Environmental Simulation Testing
AF89-022	High Surface Temperature Measurement Techniques
AF89-023	Plasma Density Measurement System
AF89-024	High Temperature Strain Measurement System
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AF89-026	In-situ Optical Property Measurement System
AF89-027	Corrosion Resistant Pressure Transducer
AF89-028	Digital Video Data Storage System
AF89-029	CAD/CFD Grid Generation Interface
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Electronic Systems Division, Hanscom AFB MA

AF89-031	Command, Control and Communications Systems/Subsystems
AF89-032	Tactical Command, Control, Communications and Intelligence (C^3I) Systems/Subsystems
AF89-033	Assessment of Electronic Systems Production Designs in Meeting Functional and Physical Requirements
AF89-034	E-3 Sensor Data Fusion Algorithms
AF89-035	Hardening Electronic Devices Susceptible to High Power Microwave (HPM) Radiation

Rome Air Development Center, Griffiss AFB NY

AF89-036	Neural Computing Architectures for Natural Language and/or Vision
AF89-037	Automated Acquisition and Dissemination of Distributed System Software Design Knowledge
AF89-038	Command, Control, Communications and Intelligence System Engineering Life Cycle Data Model
AF89-039	Strategies for Testing-Parallel Software
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AF89-041	Conformal Optical Focusing Elements for Laser Communication
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AF89-044	Antenna Pulse Pattern Synthesis in a Complex Medium
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AF89-047	Compact Ultrafast Microwave Switching
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Air Force Engineering and Services Center, Tyndall AFB FL

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AF89-058	Catalytic-Additive Combustor Lining
AF89-059	Device for Characterizing Chemical Source Strength
AF89-060	Passive Hydrogen Chloride (HCL) Monitors
AF89-061	Disposal of Solid-Rocket Motors and Propellant
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AF89-063	Characterization of Optical Fire Detector Stimuli
AF89-064	Thermodynamics of Advanced Refrigerants
AF89-065	Fiber-Reinforced Spall Protection
AF89-066	Energy Fields for Fire Extinguishment
AF89-067	System for Macro and Micro Airfield Pavement Damage Assessment

Human Systems Division, Brooks AFB TX

AF89-068	Human Systems/Subsystems Research
AF89-069	Real-Time Environmental Monitoring Capability

AF89-070	Innovative Analysis Procedures and Equipment for Environmental Health and Drugs of Abuse
AF89-071	Identification and Management of Hazardous Materials in Large Scale Systems Acquisition
AF89-072	Dynamic Bleaching of Protective Materials by Ultra-Short Laser Pulses
AF89-073	Computer Based Testing and Training in Intelligent Systems
AF89-074	Instructional Methodology for Multiship Air Combat Training
AF89-075	Unified Life Cycle Engineering (ULCE)
AF89-076	Enhanced Crew Interface Designs
AF89-077	Crew Performance Predictions and Enhancements
AF89-078	Advanced Biocommunications Transducers
AF89-079	Innovations in Aeromedical Applications
AF89-080	Chemical/Biological Defense Protection
AF89-081	Decision Aid Process for Investment Strategy
	<u>Aeronautical Systems Division, Wright-Patterson AFB OH</u>
AF89-082	Parallel Processing for Artificial Intelligence (AI) and Graphics Applications
AF89-083	Abductive and Inductive Reasoning Applied to Advanced Avionics System Diagnostics
AF89-084	Integrated Information Signal Processing
AF89-085	Language Implications for Real-Time Artificial Intelligence (AI) Systems
AF89-086	Complex Integrated Circuit Technology
AF89-087	Miniature Broadband Circulator
AF89-088	Holographic Lithography for Microcircuits
AF89-089	Picosecond Pulse Semiconductor Diode Laser
AF89-090	On-Chip Information Processing for Aerial Electro-Optical (EO) Sensing with FPAs
AF89-091	3-D Target Modeling, Representation and Perception
AF89-092	Agile Coherent Laser Radar
AF89-093	Advanced Measures of Effectiveness (MOEs) for the Strategic Relocatable Target Attack (SRTA) Mission

AF89-094	Transition and Connectivity Between Electronic Combat Digital Models and Hybrid Simulators
AF89-095	Optical Filtering for Infrared Target Detection
AF89-096	Mathematical Analysis of Linear Feedback Shift Register Sequence Generators
AF89-097	Artificial Intelligence (AI) and Parallel Processing Technologies for Electronic Combat Applications
AF89-098	Low Probability of Interception (LPI) Milstar Modulator
AF89-099	Threat Identification Error Reduction Techniques
AF89-100	Optical Interconnects for High Temperature Superconductors
AF89-101	Improved Strength Carbon-Carbon Faceplate Heatshield for Phased Array Antenna Windows
AF89-102	Time Domain Approach to Random Dynamic Response and Fatigue
AF89-103	Landing Gear Component Design Verification and Durability Determination
AF89-104	Automated Design of Global Fault Detection and Isolation
AF89-105	Computational Aerodynamic Models of Aircraft and Weapons
AF89-106	Numerical Determination of Aerodynamic Coefficients Using a Gas Hydraulic Analogy Water Table
AF89-107	Cryocooler Technology
AF89-108	Real-Time Polynomial Network Synthesis
AF89-109	Vortex Flows and Their Control
AF89-110	Life-Enhancement Techniques for Improved Fatigue Life at Elevated Temperatures
AF89-111	Surface Crazing Measurement Technique for Aircraft Acrylic Plastic Transparencies
AF89-112	Cockpit Situational Awareness - Flight Experiment Design
AF89-113	Methodology Development for Verification of Flight Critical Systems Software
AF89-114	Fatigue Crack Growth Retardation/Acceleration Effects in Elevated Temperature Environments
AF89-115	Two-Phase Fluid Heat Transfer at Low and High Accelerations
AF89-116	Abductive and Inductive Reasoning Applied to Intelligent Missile Defense

AF89-117	Mobile Autonomous Robot Simulation (MARS)-Second Generation
AF89-118	Mission-Oriented Flying Qualities
AF89-119	Attachment Techniques for High Temperature Strain Measurement
AF89-120	New High Performance Polymers
AF89-121	Modeling of Stresses in Coated Solids
AF89-122	High Performance Carbon-Carbon Composites for Advanced Applications
AF89-123	High Temperature Materials for Advanced Systems
AF89-124	High Performance Light Metal Alloys and Metal Matrix Composites
AF89-125	Improved Nondestructive Evaluation
AF89-126	Nonlinear Optical Materials
AF89-127	High Temperature Superconducting Materials
AF89-128	Ultrastructured Materials
AF89-129	Aircraft Accident Investigation Techniques for Electronic and Electrical Systems
AF89-130	Metallic Adhesives for Structural Composites
AF89-131	Contactless Electrical Testing
AF89-132	Unified Life-Cycle Engineering Design Aid
AF89-133	Low Cost Composite Structures Fabrication
AF89-134	Common Memory Data Processor
AF89-135	Biotechnology for Aerospace Materials Requirements
AF89-136	Phenomenology and Effects of Materials/Laser Interactions
AF89-137	Epistemic Planning for Management and Manufacturing
AF89-138	Determination of Mechanical Properties of Materials Subjected to Severe Environments
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AF89-150	Solid Lubricants and Their Distribution for Advanced Aircraft Gas Turbines
AF89-151	Development of Improved High Temperature Solid Lubrication Concepts
AF89-152	High Temperature Magnetic Bearing Development
AF89-153	High Temperature Gas Turbine Lubrication System Wear Monitoring
AF89-154	Solid Lubricants for Advanced Turbine Engine Powder Delivery Systems
AF89-155	Augmentor Acoustic Instability
AF89-156	Turbine Engine Test Instrumentation Techniques
AF89-157	Compression System Design Methodology
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AF89-159	Automatic Test Equipment (ATE) Requirements Specification Authoring Tool
AF89-160	Modular Automatic Test Equipment (MATE) Guide Expert Presentation System
AF89-161	Fiber Optic Delay Line
AF89-162	New Concepts and Innovations for Aeronautical Systems/Subsystems
AF89-163	Artificial Intelligence Applied to Aeronautical Systems
AF89-164	New Concepts and Innovations for Logistics Support
AF89-165	New Concepts and Innovations to Enhance the Cost Estimation of Aeronautical Systems/Subsystems
AF89-166	New Concepts and Innovations for Special Operations Aircraft Systems/Subsystems
AF89-167	Primary Aircraft Trainer Study (PATS)

AF89-168	Mission Opportunities for Airship Technology (MOAT)
AF89-169	Determination of Panel Flutter Characteristics of Kevlar-Polyester Composite Panels

<u>Space Division, Los Angeles Air Force Station, CA</u>

AF89-170	3-D Numerical Windflow Model
AF89-171	Personal Hydrazine Vapor Dosimeter
AF89-172	System to Measure Cloud Meterorological Parameters
AF89-173	System to Measure Atmospherics Meterorological Parameters
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AF89-175	System to Measure Oceanography Meteorological Parameters
AF89-176	Innovative Concepts for Improved Space Object Surveillance and Classification
AF89-177	Innovative Concepts for Space Systems and Launch Systems Cost Reduction
AF89-178	Innovative Space Systems Survivability Concepts
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AF89-181	Innovative Applications of Emerging and Mature Technologies for Air Force Space Capabilities
AF89-182	Concepts for Improved Satellite Communications Support to Theater Commanders
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AF89-187	Novel Concepts for Survivable Space Power and Supporting Technologies
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AF89-189	Development of Acceptance Criteria in Carbon-Carbon Materials for Space Structures

AF89-190 Dynamic Computed Tomography

AF89-191 Hydrogen Storage in Metal Hydrides

AF89-192 Technology for Storage, Handling or Use of Antimatter

AF89-193 Separation and Purification of Propellant Polymers

AF89-194 High-Sensitivity SWIR/MWIR Infrared Cameras

AF89-195 Ultra-Narrow Band, Tunable, Super-Sensitive IR Detector

AF89-196 Development of Remote Sensing Algorithms for Atmospheric Path Variables from Radiometric Data

AF89-197 Cloud-Free Conditions Specified from Satellite

AF89-198 Programmable Signal Processor for Real-Time Doppler Lidar Wind Measurements

AF89-199 Tunable Narrowband Optical Filters (TNOFs)

AF89-200 Nonlinear Materials Development for 0.8 and 1.315 Microns

AF89-201 Far Field Radiation Patterns in the Presence of Air Breakdown

AF89-202 Mobile Automated High Power Microwave Diagnostic System

AF89-203 Pulse Compression Techniques for High Power Microwave Applications

AF89-204 Phased Array Imaging Telescope

AF89-205 Development of Computational Methods for Chemically Reacting Mixing Problems

AF89-206 Video Optical Disk Characterization and Control

AF89-207 Excited State Populations in a Neutral Partical Beam

AF89-208 Passive and Active Countermeasures Against Multispectral Target Illumination

Air Force Ballistic Missile Office, Norton AFB CA

AF89-209 Ballistic Missile Research

AF89-210 Generic Qualification of Electronic Piece Part Processes

AF89-211 Propellant Sensitivity to Electrostatic Discharge (ESD)

AF89-212 Internal Insulation Materials for Future Generation of Solid Rocket Boosters

AF89-213 Effect of Booster Acceleration on Insulation Erosion

AF89-214 Development of Standard Door for ACS Thrusters

AF89-215	Developing a Storable Injectant for Solid Motor Performance Improvement
AF89-216	Thermal Protection Material Characteristics
AF89-217	Cost Reduction in LWIR Radiometry
AF89-218	Aerodynamics and Flowfield Effects
AF89-219	Constructing Radiation Hard Semiconductor Devices on Advanced Substrates
AF89-220	Plasma and Optical/RCS Effects
AF89-221	Site Characterization
AF89-222	Hardened High Voltage Power Supply for Ring Laser Gyros
AF89-223	Packaging Techniques to Reduce Radiation Effects on Electronics
AF89-224	Improved Basing Security, Safety and Reduced Manning
AF89-225	Signature Countermeasures and Tag/Implant Sweep Techniques
AF89-226	High Temperature Insulator
AF89-227	Development of a Heatshield
AF89-228	Non-Destructive Tests and Evaluation (NDT&E) Techniques for Rocket Motors
AF89-229	Rocket Motor Test and Display Techniques
AF89-230	Sounding Rocket Thrust Vector Control
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AF89-232	Sounding Rocket Telemetry/Tracking System
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AF89-234	Fiber Optics Ordnance Studies
	<u>Air Force Office of Scientific Research, Bolling AFB DC</u>
AF89-235	Development of New Scientific Research Instrumentation
AF89-236	Development and Application of New Theories and Concepts Relating to Fluid Mechanics
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AF89-239	Multifunctional Nonmetallic Materials Processing and Characterization
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AF89-247	Infrared Astronomy

National Aero-Space Plane Joint Office, Wright-Patterson AFB OH

AF89-248	Emerging Technologies Resulting in Lighter Aircraft Weight, Increased Engine Performance (ISP) and Improved Design Tools
AF89-249	Hypervelocity Space Vehicle Interactions and Signatures
AF89-250	High Temperature (2000+ C) Acoustic Microphones and Dynamic Pressure Gauges
AF89-251	High Temperature Fasteners and Attachments
AF89-252	Kinetics Turbulence Interaction in Reacting Flows
AF89-253	Finite Rate Chemistry Algorithms for Hypersonic Flows
AF89-254	Global Communication Strategies for Hypersonic Vehicles
AF89-255	High Temperature Non-Intrusive Diagnostic Instruments for Flow Field Measurements (with and without chemistry)
AF89-256	Visibility Requirements for Non-Instrumented Landings
AF89-257	Multiple Mode Optical Switches for Fiber Optic Networks

AF89-001. TITLE: Armament Research

OBJECTIVE: To develop innovative ideas/concepts and analysis methodologies associated with air deliverable conventional munitions/armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered non-nuclear munitions and armaments. These include energy sources and conversions, bombs, submunitions, warheads, fuzes including safe and arm devices for air-to-air missiles, dispensers, rockets, sensors and seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, analysis, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fuzing, millimeter wave seekers/sensors for mid-course and terminal guidance, heavy metal self-forging fragment warheads, heavy metal shaped charges, long rod penetrators, reactive fragment warheads, and computational fluid dynamics including interactive grid generation techniques.

AF89-002. TITLE: High-Speed High-Density Video Data Memory System

OBJECTIVE: To develop a fast acquisition video data memory system for airborne environment applications.

DESCRIPTION: The Air Force is interested in developing a video data memory system capable of acquiring and storing video data from new solid state imagers with output of up to 500 frames per second, 1024 x 1024 pixel resolution, and 8 bits per pixel. In order to provide flexibility, the frame resolution should be programmable up to 1024 x 1024 pixels. The system must store 30 seconds of data with a trigger input for storage of either the last 30 seconds or the next 30 seconds of data. In addition, the system must be capable of operation in extremely severe airborne and test range environments. It is desired that the system have a volume of less than 200 cubic inches (e.g., 3 inches x 6 inches x 10 inches). Parallel input architectures may be considered; however, the memory device must allow many rewrites. Architectures proposing parallel inputs should allow flexibility in the number of inputs per frame. The system should provide single frame digital and standard NTSC analog output. The system should have a modular design to allow storage size.

The Phase I task is to provide a detailed study of a new, high density memory technology. Emphasis should be on the memory fabrication, manufacturing processes, and packaging of the high-density memory device. The Phase II task will conduct hardware demonstrations and fabricate a prototype unit to prove feasibility.

AF89-003. TITLE: High Temperature Composite Weapons

OBJECTIVE: To explore developments in low cost, high temperature composite material for advanced air-to-air missile airframes.

DESCRIPTION: Considerable work has been accomplished in high temperature composite materials for air-to-air missile application. Unfortunately, composite material technology for these demanding flight profiles results in the use of high cost materials and manufacturing techniques. There is a need for special emphasis on the use of high technology/low cost composite materi-

als, manufacturing processes, and assembly techniques that will result in light weight, high strength, and low cost/high production rate characteristics which can be applied to asymmetric, complex shaped air-to-air missile airframes.

The fundamental goal of this program is to develop a technology base in low cost composite weapon airframe manufacturing processes for air-to-air missile applications. Specific objectives include identification and evaluation of potential low cost composite materials, manufacturing processes, and assembly techniques for an advanced air-to-air weapon.

The technical challenge is to survey the technology base in composite materials, manufacturing processes, and assembly techniques as applied to an advanced shaped air-to-air weapon airframe for the purpose of minimizing the cost of its construction.

Phase I of this SBIR task will conduct a survey of potential low cost combinations of materials and manufacturing techniques for a variety of flight envelopes and temperature profiles. The advantages and disadvantages of each combination will be reported on according to the cost effectiveness, weight, producibility, quality assurance, strength, and temperature capability. An advanced conformally carried air-to-air missile airframe will then be designed from the selected composite materials. The vehicle design must react, without degradation of performance, to the worst case free flight, ejection, and captive carriage load conditions. Finally, the Phase I task will recommend fabrication approaches to be demonstrated in Phase II.

Phase II of the SBIR task is expected to demonstrate the Phase I recommendations by the manufacture and assembly of several components of an advanced airframe. Static loads testing will be conducted to verify structural integrity of the airframe.

AF89-004. TITLE: Stored Munitions Vulnerability

OBJECTIVE: To develop munitions insensitive to detonation while in storage but function normally when fuzed.

DESCRIPTION: The Air Force maintains a variety of munitions in relatively vulnerable locations. These storage locations are prime targets because an impact (detonation) in the storage area could cause one weapon to detonate, and could potentially detonate the remainder of the weapons in the storage area. The storage areas are high-value targets due to the relatively low cost (one weapon) and high yield of a successful mission. The Air Force is developing a blast mitigation system to reduce the probability of large-scale fratricide in storage areas. The mitigation system consists of physical barriers in contact along the length of, and in contact with adjacent bombs, along with a rectangular block mounted at the center of the rectangular array formed by four bombs. The purpose of these mitigators is to deflect fragments from a detonating unit away from the adjacent and diagonal bombs, thus reducing or eliminating sympathetic detonation.

The program will concentrate on alternative methods for reducing large-scale fratricide in bomb storage areas.

AF89-005. TITLE: Extended Shelf-Life Weapon System

OBJECTIVE: To investigate methods of ensuring weapons systems can withstand a ten-year storage period.

DESCRIPTION: The Air Force's Sensor Fuzed Weapon is being designed as a no-maintenance munition capable of withstanding a storage period of ten years with no degradation in reliability. Accelerated aging tests will be conducted on the system to determine its ability to endure this period. But serious risk is involved in achieving this requirement as it is totally unproven in any other system. Legislation has recently come into affect attesting to this risk by requiring that all extended shelf-life requirements be handled on a "cost-plus" basis only. Research of methods for ensuring the shelf-life durability of complex weapons systems is a must if "no maintenance" requirements continue to be imposed on contractors. Sealed dispensers, improved storage con-tainers, sealed components and the use of desiccants are all areas of innovative research.

AF89-006. TITLE: Impact of Extended Storage Periods on Various Advanced Composite Materials

OBJECTIVE: To determine deterioration levels of advanced composite materials under various storage conditions.

DESCRIPTION: The use of composite materials for weapons and weapons systems within the Department of Defense (DOD) is increasing every year. Until recently, the primary usage had been with aircraft for which there already existed a data base which DOD could compare. The use of com-posite materials for air-to-air and air-to-surface weapons is now being seriously studied. The fundamental goal of this task is to develop a plan for testing the impact of long term dormant storage on various composite materials.

Phase I of this SBIR task is to identify composite materials in use today and recommend a plan for identifying their deterioration levels during extended storage.

Phase II of this SBIR task will be laboratory demonstration of the reaction of composite materials to simulated USAF munition storage conditions.

AF89-007. TITLE: Analysis of Ballistic Range Data Using Artificial Intelligence

OBJECTIVE: To employ artificial intelligence to expedite the reduction of aeroballistic range data.

DESCRIPTION: The development of a "User Friendly Expert System" employing the emerging field of Artificial Intelligence is required to reduce the 3-5 year on-the-job experience required to become an expert in data analysis. The technology being sought will merge the current analysis techniques with an artificial intelligence system such that the time of the learning process is substantially reduced and the quality of the technical analysis is improved.

Phase I of this SBIR task is to employ artificial intelligence in conjunction with the current "Linear Theory" analysis of experimentally measuring tiajectories. Presently a knowledgeable engineer is required to examine the data in order to make reasonable "initial guesses" for the linear theory

routines. The accuracy of these guesses greatly affects the ability of the routines to successfully fit the equations of motion to the experimental trajectory. Artificial intelligence could be used to reduce the experience needed, time and effort in this process.

Phase II of the SBIR task is to use the same type of artificial intelligence scheme for use with the six-degree-of-freedom (6-DOF) nonlinear routine. Similar initial guesses are required for the 6-DOF input in order for these routines to converge to the correct solution.

AF89-008. TITLE: Composition Control of Bulk High Temperature Superconductors for Infrared (IR) Sensors

OBJECTIVE: To demonstrate improved IR sensors using high temperature superconductors of precisely controlled composition.

DESCRIPTION: Recent rapid developments in high temperature superconductors have shown that a basic understanding of superconductivity is lacking. Very little is known about the exact mechanism of high temperature superconductivity. Any useful developments in IR sensors using high temperature superconductors will depend on a more thorough understanding of superconducting mechanism as they relate to the microstructural aspects of the material. It has been hypothesized that present materials only exhibit superconductivity along distinct paths within the bulk of the material instead of throughout the material because of the lack of composition control of the mixture during fabrication. Making practical long-wavelength IR sensors requires superconductivity to be achieved throughout the entire cross-section of the material rather that just along these distinct paths. Methods must be established for precise composition control, characterization, and standardization of bulk ceramic superconductors.

Phase I should investigate methods of fabricating superconductor sensor elements that have precisely controlled composition and microstructure. The sensor elements fabricated using these techniques will be tested to determine what effect composition control has on the relative amount of superconductivity and on measurement of critical current density versus temperature needed for practical IR sensors. Phase II will exploit favorable composition control methods for characterization and standardization of superconductor compounds for IR sen-sors. These methods shall be used in the fabrication of prototype IR sensors for testing to determine spectral response and operating temperature range.

AF89-009. TITLE: Computational Continuum Mechanics for Conventional Warhead Design and Analysis

OBJECTIVE: To develop improved computational methods and physical models for hydrocode applications to conventional weapon design.

DESCRIPTION: New methods are sought to extend current capabilities of hydrocodes using either finite difference or finite element methods to solve impact problems or problems involving the explosive acceleration of metals. Innovative developments in constitutive modeling and fracture modeling are desired to more realistically treat weapon-target interaction processes. More efficient computational algorithms are required for treatment of three-dimensional warhead concepts under con-sideration. Phase I efforts should be

limited to the evaluation of a single area of research related to either computational techniques or material modeling. Phase II efforts should demonstrate the capabilities in the framework of a research code or a temporarily modified hydrocode such as HULL, EPIC, DYNA, or any other code generally available to the research community. Follow-on efforts should address formal implementation in specific hydrocodes.

AF89-010. TITLE: Multi-stage/Multi-Mode Air-to-Surface Warhead Technology

OBJECTIVE: Develop technology for next generation of air-to-surface missiles for mobile ground target defeat.

DESCRIPTION: Improvements in modern armor technology have presented a special challenge for anti-armor missile warhead designers. This, combined with the range of vehicle types incorporated in mobile ground targets such as a motorized rifle battalion, make it desirable for the warhead to change its functional characteristics as a result of input data from either smart fuzing and/or advanced sensors. Multi-dimensional warhead design approaches are needed to increase warhead effectiveness as a result of this information flow. Some examples of required research in warhead design includes materials selection, dual/tandem warheads, fuzing/initiation requirements, and sensor requirements. Research pertaining to the next generation of smart submunitions is also needed. All work should be responsive to the developing sensor/fuzing technologies. Phase I work should focus on developing a fundamental understanding through basic research of some unique idea in the areas previously mentioned (materials selection,dual/tandem warheads, etc.).

Phase II work should exploit the understanding developed in Phase I to mature the concept and show/demonstrate potential warhead applications.

AF88-011. TITLE: Precision High Speed Test Track Position Time Data System

OBJECTIVE: To develop a system that will time sled position data to within one microsecond.

DESCRIPTION: The United States Air Force High Speed Test Track at Holloman Air Force Base, New Mexico has a requirement to obtain precision position time data on rocket propelled sleds. The sled velocities where the precise data are required range from 2000 feet per second to 8000 feet per second. The data gathering area is 1000 feet long and the 1000 foot area may be selected at any interval along the 50,000 foot long Test Track; therefore, the system must be portable. A minimum of 25 data points are required; there will be 25 time measurements to correspond with 25 positions in the 1000 foot interval. The requirement for the time accuracy is one microsecond and the implications of this are substantial. The time delays associated with an ideal telemetry system range from 2 to 33 microseconds along the 50,000 foot Test Track and there are additional delays inherent in the telemetry hardware. These delays can be calculated and measured, but they cannot be eliminated. A telemetry system will be used to transmit the time data to minimize delay times. The telemetry system will be furnished by the Test Track. The trackside data system will be surveyed in place and rigidly mounted to prevent any change in position from sled shock-waves and overpressures. The trackside data system will also have to be rugged to withstand the aerodynamic pressures and the effects of rocket motor blasts. The environmental conditions are also severe. The summer temperatures reach 120 degrees or more on the Test Track and a

shimmering effect is seen in the air waves near the ground under these conditions. Early morning temperature inversions near ground level are also a common occurrence near the Test Track.

The program will develop the hardware to obtain time data on high velocity sleds and the mounting hardware to install the trackside data system at various locations along the Test Track.

AF89-012. TITLE: Hypervelocity Launcher Research

OBJECTIVE: Advance hypervelocity launcher technology through advancements in related subsystem and diagnostic technology development.

DESCRIPTION: New and innovative ideas and concepts are desired in the area of hypervelocity launcher technology. Programs stressing either experimental research or theoretical analysis are acceptable. Proof-of-principle experiments at the system level as well as subsystem technologic research addressing critical issues for electrothermal, electro-magnetic, and advanced gas gun concepts are of interest. Desired research areas include but are not limited to hypervelocity launcher diagnostic and instrumentation techniques emphasizing data integrity in launcher hosted environments, launcher power conditioning, distribution and feed emphasizing high efficiency. The following specific examples are typical.

Velocity Measurement Diagnostics. Innovative methods for measurements of projectile velocity both in-bore and down range are sought. Desirable features include high immunity to plasma and EMP, high accuracy (.1%), high sampling rate (>1MHz), broad range (0.1-20 km/sec), rapid-fire/multishot applicability (5-10 shot bursts at 1-20 shots/sec).

Ultrasound Diagnostics for Hypervelocity Launchers. Innovative applications of highly time and/or spatially resolved ultrasound diagnostic methods to the areas of: plasma armature structural phenomenology, projectilebore interface, plasma density and boundary layer, dynamic measurements of barrel structural integrity, bore erosion and real time telemetry.

High Temperature Superconductor Opening Switch. Innovative methods for a solid state high current opening switch employing high temperature superconducting material are sought. With rapid fire electromagnetic launcher application as the goal the required technologies include; high cooling rate high temperature structures, fabrication techniques, rapid-uniform quenching methods, and high current normal conductor interfaces.

AF89-013. TITLE: Computational Fluid Dynamic Model of Projectile Impacts into Fuel Tanks

OBJECTIVE: Use computational fluid dynamic (CFD) models to simulate the reactions within fluid-filled tanks.

DESCRIPTION: Air-to-air missile warhead fragments that impact onto aircraft targets can produce damage from a number of causes. One such cause is rupture of fuel-filled fuel tanks positioned around the air inlet to the aircraft engine. Another cause is complete penetration through the fuel-filled tank, exiting the tank and damaging components buried deep inside the aircraft, such as the engine. CFD methods may be helpful in determining the reactions to

impacting warhead fragments caused by the fuel in the aircraft fuel tanks. These reactions will dictate whether or not the fuel tanks rupture, or whether or not the fragments pass completely through the tanks before they lose their total velocity and are entrapped within the tank.

The fundamental goal of this SBIR task is to model the impact of a warhead fragment of given size, weight and striking velocity into a fuel-filled tank. Then, the reactions of the fragment, the fuel and the tank will be described in theoretical terms.

The technical challenge is to develop the CFD techniques that apply to this highly transient event, over the critically short time periods wherein the fragment's momentum/energy is transferred to the fluid, and ultimately the tank and tank supports.

Phase I of this SBIR task is to identify available data on impacts of warhead fragments on fuel tanks, and to review literature in the technical area of hydrodynamic ram. Preliminary studies will be made of the controlling parameters describing the phenomena of fragment penetration into fluids. The purpose of this initial task is to identify the feasibility of using CFD to predict effects on warhead fragments from fuel-filled tanks. The feasibility germination shall be demonstrated by sample CFD computations illustrating some facets of the total problem.

Phase II of this SBIR task will be directed towards a full demonstration of CFD analysis of a fuel-filled tank impacted by warhead fragments. The Phase II effort will include tank rupture from fragment impact, complete perforation of the tank where the fragment enters one side and exits the other, and the case where the fragment merely loses its total impact velocity and is captured within the fluid.

AF89-014. TITLE: Innovative Methods for Target Detection in Aerosols

OBJECTIVE: To demonstrate improved target detection devices that can discriminate a target in an aerosol.

DESCRIPTION: The Air Force Armament Laboratory is interested in innovative optical techniques for target detection through aerosols. Although all-weather optical fuzes would be ideal, current optical fuzes are limited by the inability to operate reliably in or through aerosols.

Phase I is a feasibility study to evaluate unique passive and/or active optical fuzing techniques. The techniques considered should be evaluated on the basis of performance (especially in aerosols), complexity, cost and reliability.

Phase II should use the information gained in Phase I to construct breadboard optical fuze sensors for testing. The most promising concept(s) shall be constructed and tested for ability to discriminate a target in an aerosol environment.

AF89-015. TITLE: Innovative Methods for Fabrication and Polishing Conical Fiber Optic Arrays

OBJECTIVE: To demonstrate polishing techniques that maximize optical throughput while minimizing internal reflections.

DESCRIPTION: The Air Force Armament Laboratory is interested in innovative techniques for fabricating optical target detection devices. Current array fabrication and polishing methods are inadequate to reach desired performance levels. Making practical fiber optic arrays for sensors requires control of the fiber-to-holder bonding to reduce damage to the fibers during polishing as well as improved methods of coupling between fibers, laser diodes and photodetectors. Also improved performance and uniformity of optical splitters (star couplers) is desired.

Phase I of the task should investigate methods of conical array fabrication and polishing. The arrays fabricated using these techniques shall be tested to determine throughput and losses due to internal reflection.

Phase II of this task shall use the information gained in Phase I to fabricate a breadboard optical target detection device and to characterize its performance.

AF89-016. TITLE: Application-Specific Integrated Circuits for Weapons Effects Assessments

OBJECTIVE: Evaluate the use of application-specific integrated circuits (ASICs) in conventional weapon technology assessments.

DESCRIPTION: The DOD services have developed a mature technological foundation for the evaluation of conventional weapons effects against all types of materiel targets. The fundamental objective of this task is to evaluate the potential cost savings, if any, that may be realized in computer resources expended (computer time costs, mini-computer purchases, code architecture studies, etc.) in running computer codes standard within the DOD using ASICs. Trade-offs need to be evaluated in costs of ASICs that are dedicated to certain repetitive computations against the ordinary costs of running FORTRAN computer programs on mainframe or mini-computers.

Phase I of this SBIR task will analyze existing weapons effects computer programs, identify areas that may be appropriate to ASIC applications and access the projected cost effectiveness of using ASICs in place of computer code computations on a variety of computer hardware.

Phase II of the SBIR task is expected to be the application of a specific ASIC prototype to a specified portion of a weapon effects program, so that the results of the methods that use ASIC technology can be compared to those using simple computer codes.

AF89-017. TITLE: Innovative Technology for Rapid Area Clearance of Unexploded Ordnance

OBJECTIVE: Investigate innovative technologies for rapid area clearance of unexploded ordnance from critical areas.

DESCRIPTION: Enhanced Base Recovery After Attack (BRAAT) operations are needed to restore sortie generation capability as soon as possible. The Air

Force is looking to advanced technology to provide BRAAT operations. The first step in the BRAAT process is to remove, destroy or neutralize unexploded ordnance, including large numbers of anti-personnel and anti-materiel submunitions dropped on the air base to impede BRAAT operations. Current explosive ordnance disposal (EOD) operations are conducted very slowly and deliberately on a one person/one munition basis. One improvement currently being pursued by the Air Force involves the development of an armored bulldozer equipped with a clearance blade to push submunitions from critical hard surfaces. This approach has some limitations and more importantly does not solve the complete, overall rapid area clearance problem. Most current R&D efforts are oriented toward the range clearing problem (priority on safety, but slow) or the minefield breaching situation (rapid, but clears only a narrow strip). The air base rapid area clearance situation is not being addressed. In addition, with the expected development of increasingly sophisticated munitions, submunitions and mines the rapid area clearance problem will become even more difficult in the future.

Phase I will investigate advanced and innovative technologies to determine those applicable to rapid area clearance of unexploded ordnance from critical air base sortie generation facilities.

Phase II will develop a feasibility demonstration of the most promising approaches.

AF89-018. TITLE: Miniaturization of Signal Processing Components for Guided Interceptors

OBJECTIVE: Identify methods of minimizing the mass and volume of on-board processing electronics for guided weapons.

DESCRIPTION: The Air Force is currently investigating technology that involves design of guided interceptors where mass and volume are severely restricted and processing of images at a very high rate is required. The processors must be able to handle data from over 16,000 pixels at a 100Hz rate, and must perform a series of operations on each pixel for each frame. The processor must be able to withstand harsh space and launch environments. The Air Force is interested in innovative approaches to reducing the processor volume, mass and power requirements while maximizing the capabilities of the unit. New technologies such as very high speed integrated circuits (VHSIC) and gallium arsenide seem to have shortfalls in meeting the needs for the processor. An innovative technique is required to meet the far-term interceptor weight goal, and must maximize the use of available space and weight for processing. Techniques such as combination of functions between the sensor, signal processor and structural support of the unit are of particular interest. Use of preprocessing techniques to remove background information and limit processing time are also of interest.

The primary goal of this effort is to develop and test an approach for meeting the processor requirements in the allowable volume and mass.

The technical challenge is to perform standard image processing operations such as gain and offset, thresholding, centroiding, track and aim-point determination within the limited volume and mass at a very high frame rate.

Phase I of this SBIR task is to investigate different schemes for performing the functions and to develop comparisons of the capability of each to reduce

the processor weight and volume and the processing power of each scheme. The investigation will produce a report which illustrates the comparison, the maturity of the technologies and the advantages and disadvantages of each. Phase I will also result in the design of a processor using the best candidate technology.

Phase II will consist of a design and fabrication of a breadboard unit using the design developed in Phase I.

AF89-019. TITLE: Fault Tolerant Processors for Guided Interceptors

OBJECTIVE: To identify fault tolerant methods of signal and data processing for guided interceptors.

DESCRIPTION: The Air Force is currently investigating the use of signal and data processors for interceptor applications requiring long life-times, high reliability and low maintenance. Processors are required for this application which have extended operating capabilities and which include features such as redundancy and error checking. The processor to be developed from this interceptor must be able to withstand a harsh storage and launch environment and must have a shelf life of up to ten years in orbit. The ability to perform prelaunch checkout of the processor is limited due to the extremely short engagement times for the interceptor. Also, the endgame processing rate requires that the processor be functional throughout this critical time. The volume and mass available onboard the interceptor are extremely limited and therefore minimize the amount or redundancy which can be employed.

The primary goal of this effort is to develop fault tolerant techniques which will allow the interceptor to perform its mission. The developed techniques should allow for error checking of functions during flight of the interceptor and should provide for alternate paths and graceful degradation in the event of component failure.

Phase I of this effort will be a study of the requirements for fault tolerance onboard the interceptor including a list of critical functions and timing required for those functions. The study will also identify available techniques for implementing fault tolerant schemes to insure that the functions are performed. The study should include an assessment of the impact of each technique on processing speed, and on interceptor mass and volume.

Phase II of this effort will be the design and development of a bread-board processor employing the technique from Phase I which appears most capable of meeting the interceptor goals.

AF88-020. TITLE: Plastic Extrusions for Military Container Design

OBJECTIVE: Develop plastic extrusions for use in place of aluminum extrusions for military containers.

DESCRIPTION: Aluminum extrusions have proven more cost effective than steel fabrications for medium to large munitions and military equipment containers developed during the past ten years. Increasing aluminum prices and recent advancements in plastics technology may make plastic extrusions the next development breakthrough. Plastic extrusions may offer lower tooling and

fabrication costs, lower maintenance, lower weight than aluminum and "weatherable" plastics which may be able to meet a 20-year life requirement.

The Phase I effort should investigate the adaptability of existing aluminum extrusion profiles to plastic extrusions, and determine or develop suitable plastic formulations for this application. Phase I should result in candidate profiles and formulations for Phase II work.

Phase II should consist of development of prototype container(s) using Phase I candidates selected for further development, and should address major producibility concerns, such as tooling, joining and manufacturing methods.

AF89-021. TITLE: Aerospace Ground Environmental Simulation Testing

OBJECTIVE: Develop advanced test and evaluation techniques, instrumentation and facilities.

DESCRIPTION: New and innovative ideas and concepts are needed to develop facilities, methods and techniques to accomplish the testing$needed to meet requirements for aerodynamic, propulsion, space, and reentry testing. Simulation of aerodynamic flight conditions in large test facilities is a very expensive and technically challenging endeavor. Means of generating the flow conditions, the test technique and the measurement of performance and flow parameters is of interest. One specific example of a technical need is a method to heat and contain air on a large scale for true temperature conditions for testing at hypersonic flight conditions. Some examples of needs are aircraft/store separation, transonic wall interference, viscous simulation, turbulence measurement, boundary layer diagnostics, diagnostics of high enthalpy flows, hypersonic nozzle design and throat heat transfer, and real gas computational analysis. Other examples of areas of desired research are generation of hypersonic flow conditions for large scale aerodynamic, aerostructural, aerothermal, and propulsion testing in ground facilities. Generation of the test environment, measurement of the test conditions, analysis and interpretation of the test results are also within the scope of interest. Space propulsion testing, contamination effects and scene sources are of interest. Hypervelocity launchers for reentry and impact testing, along with associated operational and measurement problems are of interest. Many of the methods of simulation now used for these technical areas either involve compromise of test conditions, high cost, poor productivity, or other major problems where innovative approaches might provide much needed benefits.

AF89-022. TITLE: High Surface Temperature Measurement Techniques

OBJECTIVE: Develop instrumentation and measurement techniques to measure test article wall temperatures from 3000-4500F.

DESCRIPTION: High-enthalpy ground test facilities are currently under development at AEDC to support the development of future aerospace systems. To complement these new test facilities, significant advancement must be made in the test instrumentation to measure temperatures in the 3000-4500F range. Such intrusive techniques as thermocouples and calorimeters are limited by material survivability and application techniques. Non-intrusive techniques often rely on an accurate knowledge of temperature-dependent material properties, such as emissivity and transmissivity, which are difficult to measure even at lower temperatures. Also, current non-intrusive techniques have limited spatial

resolution and are directionally sensitive which complicates the interpretation of measurements. Emphasis for the development and validation of elevated wall temperature measurement techniques should be placed on measurement accuracy, instrument survivability for repeated use, and measurement compatibility with high temperature materials, such as those envisioned for use in future flight systems.

AF89-023. TITLE: Plasma Density Measurement System

OBJECTIVE: Develop a measurement system capable of determining free electron concentration values near models in arc heated flow fields and near the surface of hypervelocity projectiles.

DESCRIPTION: A key parameter in radar Bore Site Error (BSE) related testing is the free electron density (or plasma density) near the surface of the radar window. Radar BSE related testing is now being conducted at AEDC in the hypervelocity range/track G and the HEAT-H1 arc facility. Presently the plasma density is determined indirectly by fitting a microwave transmission model to available data. A more direct, spatially resolved technique is required in order to improve data analysis. The plasma measurement system should be capable of determining free electron concentrations at distances from 0.1 mm to 25 mm from moving surfaces with a spatial resolution of 0.1 mm. For the range/track application available measurement time is very short (on the order of 0.5 microsecond). Provisions for shot-to-shot model location variations should also be incorporated in the system design. For the arc heater application, measurements must be taken through a pulsating, turbulent, high temperature flow field. The electron concentration range from 10 to the eleventh power (10 exp 11) to 10 to the seventeenth power (10 exp 17) electrons per cubic centimeter, is of interest. A laser Thompson scattering approach is of special interest.

AF89-024. TITLE: High Temperature Strain Measurement System

OBJECTIVE: Develop the technology necessary to make reliable strain measurements in the temperature range of 2000F to 4000F for wind tunnel test applications.

DESCRIPTION: Current state-of-the-art in strain measurement is limited to approximately 1800F and is highly unreliable at the higher temperatures. A new strain measurement technique or principle may very well be required in this endeavor. The technique must be compatible with metallic, graphite, graphite composite, and possibly other advanced structural materials. This technology is needed for advanced materials testing as well as confirmation of flight vehicles to be tested in advanced test facilities (HYFAC) at the AEDC.

AF89-025. TITLE: High Temperature Flow Turbulence Measurement System

OBJECTIVE: Develop a measurement system capable of determining turbulent intensity in high temperature, high velocity flow fields generated in arc heated facilities.

DESCRIPTION: The heat-transfer rate to models in high temperature, high velocity arc heated flow fields is a key simulation parameter in reentry

systems testing. The calculated heat-transfer rates to probes in AEDC arc facilities can be significantly less than the measured values if a laminar heat-transfer math model is used. One possible reason for this discrepancy is turbulence enhanced heat transfer. A measurement system for determining turbulent intensity on a point-by-point basis in a hypersonic (Mach 2 to 9), high temperature (up to 10,000R total temperature) flow is required to characterize the flow fields and help identify the heat-transfer discrepancy. The system should be capable of sweeping a 24-inch-diam flow field in three seconds or less with a spatial resolution of 2 mm. Turbulent intensity values from 0.005 to 0.3 should be measurable to a resolution of plus or minus 0.002. A noninterference laser fluorescence technique is of special interest.

AF80-026. TITLE: In-situ Optical Property Measurement System

OBJECTIVE: Develop an in-situ optical property measurement system.

DESCRIPTION: The system must be capable of measuring the IR optical properties without the need for a sample of the surface to be removed and provide bidirectional reflectivity distribution function (BRDF) and hemispherical emissivity over the range of 2-9 micrometers. The solid surfaces may be either metallic or dielectric and may be considered to be smooth but not necessarily highly polished. IR surface properties are required on a wide variety of military hardware. The primary requirement is for aircraft engine exhaust system components. The system should be portable enough to allow optical properties to be assessed on both flat and curved surfaces (radii on the order of 30 cm). Spectral resolution of 0.1 microns and angular resolution of the BRDF of 10 degrees is desired. Compromises between cost, resolution, accuracy and measurement should be considered.

AF89-027. TITLE: Corrosion Resistant Pressure Transducer

OBJECTIVE: Develop a precision, corrosion-resistant pressure transducer suitable for rocket motor chamber pressure measurements during propulsion testing.

DESCRIPTION: Presently, most precision pressure transducers used to make pressure measurements during rocket propulsion testing are constructed of 304 stainless steel and similar metals. The transducer diaphragms are often damaged by corrosion after being used for these measurements. Gases present during these measurements include HCl and H_2SO_4. Typically, these pressure transducers cannot be removed from the rocket motors for cleaning for at least 24 hours after the test. During this period, acid residues continue to interact with the diaphragm and other parts of the transducer, gradually rendering the transducer inoperative. A pressure transducer is needed which can be used to measure pressures, without damage, in such corrosive environments. Full scale ranges from 5 to 2000 psia are needed with measurement uncertainties less than 0.5 per cent of reading from 10 to 100 per cent of full scale.

AF89-028. TITLE: Digital Video Data Storage System

OBJECTIVE: Develop a low cost data acquisition and display system which can digitize and store video data at standard framing rates and play it back for processing and off-line storage.

DESCRIPTION: The system must be capable of digitizing video images on-line at standard video framing rates of 30 frames per second with an 8 bit pixel resolution of 512 by 512. A memory capacity of 2 minutes of data is required. The hardware should interface with RS-170 video signals for both input and output.

AF89-029 TITLE: CAD/CFD Grid Generation Interface

OBJECTIVE: Develop a software package that will accept as input surface coordinate information generated by Computer Aided Design (CAD) software and transform that input into a form which is compatible with grid generation software used in the application of Computational Fluid Dynamics (CFD).

DESCRIPTION: The software package must be capable of accepting surface coordinate information as generated by existing AEDC CALMA software. Output generated by the solicited program must be in a format which existing AEDC grid generation programs (SVTGD2D/3D) will readily accept. The proposed software package must be user friendly (menu driven) and must execute on AEDC hardware, which includes both Apollo (DN580 series and above) and Silicon Graphics IRIS (1000 and/or 2000 series and above) work stations. Because of the increasing demand for flow field analysis requiring CFD, and because there are many CAD packages available on the market today, development of a program which could bridge the gap between these widely used technologies should provide a much needed addition to the users of this application software.

AF89-030. TITLE: Continuous Water Monitoring System

OBJECTIVE: Develop a system to monitor return cooling water flow from AEDC to the lake and provide an alarm for predetermined levels of selected impurities such as ethylene glycol.

DESCRIPTION: Process cooling water at AEDC is returned to Woods Reservoir and must comply with federal regulatory guidelines for concentration of impurities. A continuous monitor and alarm system is required to detect environmentally controlled compounds, i.e., oils, ethylene glycol, methyl chloride, in the cooling water return. The instrument should be accurate to a few parts per million and provide a 15 minute analysis response time to permit diversion of contaminated cooling water to a retention pond.

AF89-031. TITLE: Command, Control and Communications Systems/Subsystems

OBJECTIVE: Develop innovative concepts for Air Force Command, Control and Communications (C^3) Systems and Subsystems.

DESCRIPTION: This covers all aspects of AF C^3 systems and subsystems. Proposals may address subjects not specifically given in other SBIR topics. Proposals may be for any aspect of AF C^3 missions including: Strategic C^3; General Purpose Forces C^3; Ballistic Missile Tactical Warning/Attack Assessment C^3; Atmospheric Surveillance and Warning; World Wide C^2; Air Traffic Control; all AF ground based and airborne early warning systems; all communications systems; and C^3 Countermeasures and Electronic Warfare. This topic offers great flexibility to both proposers and Air Force managers. Past submissions included: advanced communications systems concepts, data base

management systems, novel information processing systems, multilevel communications security concepts, artificial intelligence applications to AF systems, air surveillance systems and target detection systems. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF89-032. TITLE: Tactical Command, Control, Communications and Intelligence (C^3I) Systems/Subsystems

OBJECTIVE: Develop innovative concepts and initiatives for Air Force tactical C^3I systems and subsystems.

DESCRIPTION: Topic centers on increasing the warfighting capabilities of the Tactical Air Force°s (TAFs) in the areas of command, control, communications and intelligence. The systems covered in this topic include, but are not limited to, the Airborne and Ground Tactical Air Control System (TACS), NATO Air Command and Control System (ACCS), and the Korean TACS (KTACS), and improvements to these systems. Specific areas of interest are interoperability in joint and combined operations, upgrades and improvements through technology and application of existing and planned systems into architectures for the future. Proposals may address specific element, such as the Tactical Air Control Center (TACC) of Air Support Operations Center (ASOC). New Concepts can also be explored addressing technology's impact on future systems in terms of operational capability, logistics, mobility, etc. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF89-033. TITLE: Assessment of Electronic Systems Production Designs in Meeting Functional and Physical Requirements

OBJECTIVE: Develop methodology to determine whether production designs can meet functional and physical requirements of electronic systems under development.

DESCRIPTION: When applying the available technology to produce an electronic system, during transition from engineering design to production design, undesired characteristics may enter the production design. These characteristics can result in the production design not meeting system physical or functional requirements. The DOD acquisition activities cannot afford to uncover such occurrences late in the development cycle, or worse, during production. Examples of these characteristics are: crosstalk and reflections on electrical conductors; line delays and impedance changes; hardware factors such as package lead pitch, printed wiring board line widths and spacing, dielectric thickness, buried vias; and other such physical or electrical hardware characteristics may cause these. The goal of this effort is to develop a tool using latest state-of-art techniques or tools such as pattern recognition and classifier theory, artificial intelligence, or expert systems to enable contractor and government engineers to identify these undesired effects in candidate production designs and correct them.

AF89-034. TITLE: E-3 Sensor Data Fusion Algorithms

OBJECTIVE: Develop algorithm(s) for air surveillance data/sensor fusing (merging) to eliminate multiple tracks from a single target/track.

DESCRIPTION: The E-3 AWACS currently has several on-board surveillance sensors, e.g. radar and IFF, and several more under development. As the number of sensors increases, the air surveillance picture displayed at the operator's console becomes more cluttered and confusing when a single target appears as multiple sensor outputs on the display. Fusing (merging) of several tracks for the same target into a single track is highly desirable to simplify the surveillance picture for the operator and to increase target track and identification accuracy. Innovative algorithms which can fuse data for up to 4000 simultaneous targets from each of up to 10 different senors need to be developed. The development of such algorithms may include demonstrations and evaluations under different wartime scenarios using computer simulations.

AF89-035. Title: Hardening Electronic Devices Susceptible to High Power Microwave (HPM) Radiation

OBJECTIVE: Develop High Power Microwave (HPM) hardening techniques for incorporation into existing C^3I systems.

DESCRIPTION: At high microwave and millimeter wave frequencies the signal power burnout thresholds determined for Electromagnetic Pulse (EMP) excitation are no longer valid. There is considerable concern over the susceptibility of electronic components to High Power Microwave (HPM) signal injection. Lead inductances, stray frequencies significantly alter the equivalent circuit and component response at HPM frequencies. Many ground-based and airborne electronic systems not originally threatened by HPM radiation, were developed with commercial advanced state-of-the-art components that are highly susceptible to HPM effects.

The purpose is to develop HPM hardening techniques which can be incorporated into existing microwave/millimeterwave equipment, sensors and other C^3 subsystems without significant system modification. A few of the typical systems of concern are Tactical Air Control Center (TACC), E-3 AWACS, JTIDS, HAVE QUICK, SINGARS and TRACALS. These systems are composed of many subcomponents (Radars, Radios, Microwave, Troposcatter, computers Power Systems, etc). The effort should concentrate on one of two subsystems with a rationale for their selection. The product will be a description of potential hardening devices/techniques, effectiveness of each technique or combinations of techniques and complexity (cost, etc) of specific subsystem installation and support/maintenance requirements. Phase II would complete above efforts and develop product specification for selected techniques(s) and produce an initial proof-of-concept hardware demonstration package.

AF89-036. TITLE: Neural Computing Architectures for Natural Language and/or Vision

OBJECTIVE: Develop and demonstrate a methodology for interfacing fine-grained neural computing architectures with human elements such as speech and/or vision.

DESCRIPTION: One of the most important problems confronting machine designers has been that of directly interfacing computer technology with human elements. Recent advances in neural computing, parallel and optic computing, an linguistics render feasible the goal of natural language and vision interfaces for computer systems. Neural computing permits the implementation of learning

through rules, while new architectures can provide the performance needed by highly concurrent execution. In order to verify these concepts, different approaches should be experimented with for knowledge representation and retrieval using neural computing techniques. These should include associative retrieval, layered representation, and interaction among different knowledge sources (such as a blackboard system). Parallel architectures as well as optical computing techniques should be investigated. Phase I would investigate these alternatives and Phase II would develop a simulation environment as a testbed of simple applications.

AF89-037. TITLE: Automated Acquisition and Dissemination of Distributed System Software Design Knowledge

OBJECTIVE: Develop a software tool capable of acquiring and disseminating the knowledge required to design time-critical applications for distributed computing systems.

DESCRIPTION: High performance distributed computing systems promise a revolution in computing power and reliability. These new architectures make it possible to design systems which can meet demanding response time, throughput, and availability goals. However, revolutionary advances in software design practice will be required before the potential of distributed architectures can be realized. To accomplish this, system designers must be provided with appropriate design knowledge for exploiting the parallelism in their applications. Issues such as task communication and synchronization, shared memory management, software to hardware mapping, and operation during failure modes must be addressed. Managing the complexity and quantity of the software design information for effective use of distributed computing systems requires an automated software tool to assist in its distribution. In addition, because design rules are highly specific to the architecture and the application, an automated tool for distributed system software design knowledge is also needed. The knowledge acquisition tool must be able to transform general software design guidance into architecture and application specific design rules. Phase I will find measures of performance and means of control for time-critical distributed system software designs, design a software tool for dissemination of distributed system software design knowledge, and propose and evaluate a method for acquiring application and architecture specific software design knowledge. Phase II will demonstrate the feasibility of the proposed design through prototype construction and evaluation. This prototype will be used to develop specific software design rules for a selected distributed system application.

AF89-038. TITLE: Command, Control, Communications and Intelligence System Engineering Life Cycle Data Model

OBJECTIVE: To specify a data model of the Command, Control, Communications, and Intelligence (C^3I) system engineering and development life cycle, and describe an associated system life cycle toolset.

DESCRIPTION: Modern C^3I systems are ever-increasing in sophistication. Because of their heavy reliance on computer systems, they are placing an increasing burden on system/software engineering and development technology. As a result, there is a critical need for an integrated environment of advanced and sophisticated system/software engineering and development tools to support both the technical and management aspects of the system development

process. Of major importance is an environment's life cycle data base as the integrating mechanism which facilitates 1) the transition of data across life cycle phases, 2) the sharing of data by tools, and 3) the automated production of formal life cycle products.

The technical challenge for Phase I of this effort is to specify a data model, or schema, that identifies and defines all technically oriented data created and manipulated during the Air Force C^3I system development life cycle. Identification of data shall be driven by pertinent Air Force and DoD system/software development regulations and standards (i.e. data explicitly identified or implied by the regulations and standards that is ultimately used in the preparation or fabrication of formal deliverables or products). The data model shall be specified using Entity-Relationship (E-R) modelling techniques and shall be documented, both textually and graphically, in a technical report.

Based on the Phase I data model, Phase II shall investigate state-of-the-art computer aided software engineering (CASE) and computer aided design/computer aided manufacturing (CAD/CAM) tools which are capable of supporting the creation and manipulation of life cycle data identified in the data model. The Phase II technical report shall describe these tools, as well as requirements for new, non-existant tools, and their association with the data model. In addition, because data requirements have evolved from the need for relatively straightforward, conventional information to sophisticated knowledge about a particular application domain, Phase II shall also investigate and identify data model design alternatives for an intelligent database manager. The database manager would provide highly efficient storage and management of large, shared stores of both knowledge-based and conventional data, allowing the data to be collectively used by both knowledge-directed and conventional tools.

AF89-039. TITLE: Strategies for Testing Parallel Software

OBJECTIVE: To identify and develop innovative approaches to testing software developed for high performance computer architectures.

DESCRIPTION: Rapid advances have been made along several lines of high performance computer architectures, ranging from fine-grained parallel systems to course-grained systems to neural-network machines. Producing high quality software to match the high performance potential of these machines promises to be very difficult, with testing of parallel software being an immediate problem. Testing parallel software for reliability rather than just for functional acceptance is also desirable for these machines. This effort seeks to develop improved software test techniques for parallel software by assessing the current status of testing capabilities for high performance architectures and to identify and develop those techniques with the greatest potential for producing reliable software systems. New solutions are needed to deal with the testing problems of massively parallel architectures and new tools should be explored for dealing with this problem (such as program visualization to make sense of voluminous data generated in high performance architectures or animation for showing the structure of an algorithm and its execution path as it is processed). Phase I should result in a technical report that identifies and assesses the potential of several approaches to testing parallel software. Proof-of-concept demonstrations against sample testing problems should be furnished for the techniques with the highest potential. The report should recommend the technique(s) with the greatest potential for

producing high quality software and outline a research plan to develop the chosen technique. For Phase II, the development plan should be refined and implemented. The end product should be a prototype software package which assists in automating the software testing technique for parallel software.

AF89-040. Title: High Modulation Rate Optical Transmitter

Objective: To develop innovative concepts/designs for high rate optical modulation of analog RF signals.

Description: Photonic technology at semiconductor laser wavelengths has demonstrated high payoff as an RF waveguide alternative either for remoting of antenna systems at the radio frequency or in implementation of phased array antennas. Such systems are EMI/RFI/EMP tolerant and provide significant advantages over conventional RF waveguide implementation. Requirements exist to implement such systems at center frequencies up to 60 GHz. Typical bandwidths are 10-20% of carrier. Novel designs/applications of materials are necessary to implement modulators capable of functioning at radio frequencies up to 60 GHz by modulating the RF signal onto a semiconductor laser. Phase I will investigate approaches and candidate designs. Phase II will fabricate and demonstrate a high modulation rate optical transmitter.

AF89-041. Title: Conformal Optical Focusing Elements for Laser Communication

Objective: Develop innovative concepts for conformal optical focusing elements in laser communication detection.

Description: Current laser communication systems utilize telescopes and electro-mechanical control for signal detection. This approach is bulky and inflexible and makes application aboard moving platforms, e.g., aircraft, difficult. Optical detectors are of small size, thus they need focusing elements to gather the light energy. Use of telescopes requires expensive mechanical control. This project seeks to develop innovative methods to result in conformal focussing elements, which could be controlled electro-optically; this would allow for greater field-of-view, more compact designs and higher signal availability, thus resulting in greater system utility. Use of holographic elements as focusing devices is a possible approach. Phase I will provide proof of concept feasibility and Phase II will provide design, fabrication and demonstration of a conformal focusing element.

AF89-042. TITLE: Low Noise Gigahertz Electro-optic Components

OBJECTIVE: Develop electro-optic components that improve microwave performance of fiber optic phased array beamforming networks.

DESCRIPTION: Fiber optic beamformers for microwave array antennas presently suffer from poor impedance match of electrooptic components, mediocre SNR and dynamic range, and slow switching times between beam positions. The lack of impedance matching circuitry in today's laser diodes and photodiodes results in poor electro-optic conversion efficiencies. Noise sources include link reflections, phase noise and up-converted dc noise in the laser, and shot noise in the photodiode. Slow switching times are due to the present lack of integrated electro-optic switches. This effort seeks to develop components at the 0.85 micron wavelength which reduce noise and/or improve impedance match-

ing and switching speed. Possible considerations include laser diodes, photodiodes and intensity modulators impedance-matched to 50 ohms, thin-film optical isolators, intensity modulator arrays, and novel electro-optic switches with equal numbers of input and output ports in powers of two. Phase I will provide proof-of-concept feasibility and phase II will provide design, fabrication, and testing of the components.

AF89-043. TITLE: Integrated Design of "SMART" Phased Array Systems

OBJECTIVE: Define design principles for a smart phased array system which integrates digital beamforming with self-monitoring of array performance with limited automatic failure compensation, and with rapid (microsecond) nulling.

DESCRIPTION: In surveillance applications, highly integrated digitally beamforming phased arrays will be needed that combine array failure detection and compensation with protection against blinking jammers. Integration will be achieved with a multiprocessor interconnection network, the bulk of the processing taking place at the antenna elements in order to minimize high data-rate, wide bandwidth communications with a central computer. The design is to be as economical as possible, and should allow for the possibility of adding, in a follow-up project, a further stage of smartness in which the integrated (neural-like) network becomes capable of discriminating among a limited set of targets.

In Phase I the black box design of a digital network should define the functional and algorithmic requirements. Pick only a few but typical types of error for correction or functional compensation, specify the adaptive algorithm best suited for near real-time nulling, and demonstrate the functional compatibility of integrated operations. In Phase II, a specific design is to be proposed and tested, with maximum use of simulators.

AF89-044. TITLE: Antenna Pulse Pattern Synthesis in a Complex Medium

OBJECTIVE: Synthesize aperture distributions that compensate for focusing/defocusing of pulsed beams in the ionosphere.

DESCRIPTION: Pulsed electromagnetic beams launched in the ionosphere are subject to two kinds of deformation that tend in opposite directions without, however, cancelling each other: a) self-focusing due to the removal of electrons from the pulse trajectory (lens effect), and b) defocusing due to fluctuations in the electron density. Effect a) has been studied in the past, but the tools for studying effect b) have only just become available (R. Mazar and L. Felsen, URSI June 87 Symposium). Two types of pulses are to be considered: a) pulses for which a carrier frequency is defined (e.g., normal radar pulses), and b) the novel "focus-wave" pulses, i.e., the non carrier-based localized energy packets recently introduced by J. Brittingham, R. Ziolkowski, A. Sezginer, and T. Wu.

Phase I:

Prepare curves for the self-focusing of type a and b pulses in the ionosphere under conditions producing maximum deformation of the beam, for frequencies from UHF into the infrared. Use the known deterministic ray paths and initial conditions of the geometric theory of diffraction to construct initial conditions for ray-centered transport equations governing the statis-

tical moments of high frequency fields in weak large-scale random fluctuations. Apply this technique to calculate the maximum defocusing effects to be expected i· the ionosphere, for frequencies from UHF into the infrared.

Phase II:

On the basis of results obtained in Phase I, compute and discuss numerical values for the combined self-focusing and defocusing of pulsed beams (types a and b) under typical conditions in the ionosphere, for frequencies between UHF and the infrared. Propose phase corrections in large aperture phased arrays that will at least partially compensate for selffocusing and defocusing effects in both type a and b pulsed beams.

AF89-045. TITLE: Self-Survey of Distributed Thinned Phased Arrays

OBJECTIVE: To compare experimentally the performance of self-survey techniques with adaptive beamforming in distributed arrays.

DESCRIPTION: Very large, distributed, thinned phased arrays are a candidate for space-based sensors. They will suffer significant mechanical distortion due to their large size and lightweight. Such arrays will require self-calibration or self-cohering procedures in order to correct for this distortion. Two basic approaches to self-cohering have been suggested, self-survey and adaptive beamforming. Self-survey, using multiple laser ranging devices, calculates the position of all elements in an array, one to another. With accurate knowledge of element or subarray positions, phase correction can be made in order to focus and steer the array over wide angular sectors both on transmit and receive.

Adaptive beamforming ignores the relative position of the elements and uses the phase measurement from a beamforming source to focus the array over a localized region around the source. Refocusing is necessary to cover extended angular regions. Both approaches have merit and drawbacks, suggesting that a combination of these techniques should also be considered. Phase I of this effort should contain a comparison of the two approaches, an assessment of equipment requirements, and expected performance. A study of errors and the impact of errors on total system performance should be made, followed by the design of an experiment to demonstrate the two techniques for comparison. The Phase II effort should contain the experimental demonstration of self-survey and adaptive beamforming for comparison. A second objective of Phase II should be a demonstration of a combination of the two techniques.

AF89-046. TITLE: Airborne Testing of Active Aperture Arrays

OBJECTIVE: Develop a means of testing active aperture phased arrays by utilizing the doorway or other openings in the aircraft outerskin to mount an antenna system.

DESCRIPTION: Exhaustive testing of active aperture phased arrays will be required before the concept of "smart skins" becomes a reality. Ground testing of these new antenna systems is one step to flight test. Economical means of flight testing is sought. One answer would be to utilize the openings afforded by personnel, doorways and freight doors. These 'breaks' in the aircraft skin are already designed into the superstructure. A means is sought to "palletize" an antenna system demonstration to fit into the opening of the

doorway. These structures will be conformal to the wide-body and support the aerodynamic loads. Normal doorways should hold a sensible-sized array for testing and by mounting the entire system to an easily removed "pallet," the antenna may be designed, built and tested on the ground.

Phase I should provide an assessment of the efficacy of this concept along with a study of what size doors and hatchways are available on typical wide-bodied aircraft.

Phase II should include the complete design to the component level of a typical conformal antenna system. Solution to the problems of a) integration with the host aircraft power system, (b) cooling the array, c) the mechanical integration to the door frame and d) removal of the test fixture for ground test.

AF89-047. Title: Compact Ultrafast Microwave Switching

OBJECTIVE: Develop photonic technology for switching microwave transmission lines at speeds of a few picoseconds at high R.F. voltage.

DESCRIPTION: Ultrafast switching of segmented charged microwave transmission lines has recently been used to generate short pulse microwave signals at kilowatt power levels. Present technology uses large solid state lasers as drivers producing microjoule pulses of picosecond duration, to activate photoconductive microwave switches. For most Air Force applications, significant reduction of both system size and weight is necessary. A direct approach is development of more compact efficient ultrafast semiconductor or solid state laser drivers and/or more efficient semiconductor switches. However, other generically different approaches may also be possible. An important feature of this switching requirement is the precise timing of the switching event to provide synchronization to within a picosecond and allow time delay among multiple switches with low jitter. Both closing and opening microwave switching techniques are of interest. Phase I should result in a technical report supporting the design of a compact, lightweight microwave switching technique of the required picosecond timing precision and power handling capability with hardware demonstration of at least one switch. For Phase II, switching of multiple segments of transmission line with multiple switches shall be demonstrated. Switching precision and synchronization will be measured along with demonstration of controllable delay and low jitter among switches.

AF89-048. TITLE: Ion Beam Modification of Ultrastructure Properties

OBJECTIVE: The objective of the proposed effort is to investigate ion beam modification of ultrastructure layers during growth.

DESCRIPTION: Low energy particle bombardment of the deposition layer during thin film deposition has been shown to significantly effect the physical properties of the resulting film. Ion beams have been used to densify films, improve the wear and oxidation resistance, lower deposition temperatures and amorphize crystalline layers. This effort seeks to study the effects of ion beams during deposition on the properties of thin multilayered ultra-structures. Of particular interest are the little studied effects of film densification and the amphorphous/crystalline aspects. Phase I will involve a simple proof-of-concept by demonstrating ion beam assisted growth and testing

of a multilayered structure. Phase II will be a much more thorough study of the properties of various ion beam modified ultrastructures.

AF89-049. TITLE: Ternary Spatial Light Modulator

OBJECTIVE: Develop a light valve for optical computing capable of modulating light with three different and distinct states.

DESCRIPTION: Optical computing and signal processing holds the promise of extremely high data throughput rates due to its innate parallelism. The recent introduction of the binary phase-only filter has made real-time optical pattern recognition possible, as several breadboard systems have demonstrated. Recent computer simulations have shown that if a third state (a null of zero state) could be incorporated into the spatial light modulator (SLM) containing the correlation filter, system performance would be considerably improved. It might be possible to modify existing binary SLM's to include this third state. Phase I should result in a techical report demonstrating feasibility of the concept and preliminary design, and Phase II will be fabrication and testing of the ternary state SLM.

AF89-050. TITLE: Amplifying Optical Switches

OBJECTIVE: Develop lossless 2 x 2 and N x N guided-wave electro-optical switches by using optical amplification in laser-like III-V quantum-well waveguides.

DESCRIPTION: Waveguided optical amplifiers can, in principle, overcome all losses inherent in an N x N integrated-optical switching network, but this concept has not been put into practice. This effort seeks to develop new lossless electro-optic III-V semiconductor switches comprised of reflectorless channel waveguides with forward-biased gain segments, and reverse-biased loss segments. The ridged or buried index-guides would have cross-sections that resemble a bulk-heterostructure or multiple-quantum-well laser diode. A possible approach to switching is to change the bias polarity on certain segments of a branched waveguide. On desired transmission paths, gain would overcome the 3 dB branching loss. On "blocked" paths, electroabsorption would attenuate the light by 30 dB. Wavelengths on the long-wave side of the gain spectrum appear optimum. Spontaneous emission noise, both dc and rms, is an issue. Phase I will provide an experimental proof-of-feasibility in a 1 x 2 or 2 x 2 switch. Phase II will provide sophisticated working models of quantum-well 2 x 2 amplifying optical switches that have been optimized for high performance.

AF89-051. TITLE: Avionics Applications of Ambient Temperature Superconductivity (ATSC)

DESCRIPTION: Confirmation of room temperature operation for superconducting materials (ASC) systems is imminent. This opens the door to entirely new technologies that are not merely extrapolations of helium temperature devices. Applications are sought for early incorporation of these technologies into avionic systems. The applications must include a realistic description of materials processsing and manufacturing techniques. The following are some specific examples of potential uses of ATSC materials:

a. Thermoelectricity: Ultrastructures of ASCs with thermoelectric materials show broad potential for electronic spot cooling.

b. Solid State Synchron sources for X-ray lithography.

c. Extra Low Frequency (ELF) Magnetometry. ATSCs will permit extreme sensitivity and dynamic range for devices employed by Earth and Planetary Sciences, Medicine, Biology and the Physical Sciences. Phase I efforts will be directed at establishing proof of concept within a given ATSC system. Phase II efforts must include operation of a prototype system of the new application. The Phase II proposal should detail the materials processing techniques and potential failure mechanisms and limitations of the approach.

AF89-052. TITLE: 3-Dimensional Optical Memories

OBJECTIVE: Develop innovative concepts/architectures for three dimensional optical random access memories.

DESCRIPTION: Progress and the development of technologies supporting command, control, communications and counter measures (C^3CM) wideband communications and information handling are leading to requirements for small, non-mechanical, high capacity, extremely high access memories for supercomputers. The potential for using photonic concepts on crystalline or photo chemical materials offers solutions to the input/output (I/O) limitations of today's memories. During Phase I, this project seeks to define component technologies, explore architectures, etc., to accommondate orders of magnitude increases in throughput rate and access time. Phase II of this effort will refine the concepts exploited and demonstrate via breadboard model appropriate configurations.

AF89-053. TITLE: Natural Language Understanding for Message Dissemination

OBJECTIVE: Determine the feasibility of using natural language processing techniques in the area of disseminating intelligence message traffic.

DESCRIPTION: Contemporary message handling systems route and retrieve free-text messages by keyword search, in some guise. Formatted fields in the header are sometimes used in conjunction with keywords. Although the keyword approach is efficient and simple, it is also imprecise. Keyword approaches can miss needed messages and can select irrelevent messages. The keyword approach lacks the inherent capability for high precision because it ignores information about multiple word senses and the relationships between words. Phase I will determine if natural language understanding techniques can improve message selection for dissemination. Phase I will evaluate existing natural language techniques, while Phase II will implement the selected technique and demonstrate dissemination improvements based on natural language processing.

AF89-054. TITLE: Applications for Multi-Spectral/Multi-Source Imagery

OBJECTIVE: Analysis of the applicability of Photonics to the processing, exploitation and display of multi-spectral/multi-source imagery.

DESCRIPTION: Historically, the volume of data and the complexity of computations associated with high resolution image processing has rendered the concept of near real time imagery exploitation as unachievable. With the growing need of the intelligence community for multi-spectral/multi-source exploitation, the magnitude of data volumes and processing complexities have grown significantly. Practical implementation of the required intel exploitation capabilities, using conventional technologies will lengthen the time between collection and production of useful intelligence. The application of Photonics technology to this offers the potential of significantly reducing processing times. The new phenomenology and computational methods may offer the potential of significant advances in; image transfer rate, image transformation, dissimilar image correlation, automatic feature/target detection, image compression, image model (3-D) interaction and image product transmission. Phase I will address a high level assessment of Photonics application to the functions associated with high resolution multi-spectral/multi-source imagery exploitation. It will result in a report on the results of the analysis, identification of critical technical issues and, if warranted, recommendations for a comprehensive program to apply Photonic technology in this area. Phase II will consist of a limited set of experiments which will demonstrate potential applications and the scope of technical challenges to be encountered.

AF89-055. TITLE: Massive Optical Fan-in/Fan-out

OBJECTIVE: Develop technological approaches for achieving massive optical fan-out and fan-in for Digital Optical Computing applications.

DESCRIPTION: One theoretical approach for an optical central processing unit involves free space or guided fan-out of a dual rail vector of optical control and data lines to a rectangular mask, followed by fan-in in the orthogonal direction. Optical OR logic is performed at light-transit speeds. The fundamental problem here is that there is no clear way to practically provide the massive fan-in, fan-out and masking needed to provide computing performance competitive with electronic technology. An initial concept development phase (Phase I) will be followed by proof-of-concept demonstrations (Phase II).

AF89-056. TITLE: Civil and Environmental Engineering Research

OBJECTIVE: To develop new and innovative ideas/concepts in the areas of civil and environmental engineering.

DESCRIPTION: Civil Engineering research includes postattack damage assessment and repair of facilities and utilities; firefighting chemicals and training; postattack assessment of damaged runways and taxiways; advanced construction materials for facilities and airfield pavements; noise and sonic boom effects on structures; small-scale modeling techniques for structural testing; hardened air base facilities for protection against nonnuclear attacks; rapid runway repair; contingency launch and recovery surfaces; roughness of aircraft operational surfaces; aircraft shelters; tactical shelters; passive defense techniques; airfield pavements; geotechnical engineering; foundation engineering; site selection; structural analysis of air base facilities; advanced power systems; alternate energy sources; and aircraft fire/crash/rescue equippment. Environmental Engineering research includes environmental behavior and fate of Air Force fuels and chemicals; hazardous waste minimization; treatment

and pollution control; environmental chemistry; advanced pollutant monitoring technology; pollutant transport; biodegradation of pollutants; and new concepts to eliminate, substantially reduce, or mitigate environmental consequences of future Air Force weapons systems.

AF89-057. TITLE: Regeneration of Vapor-Phase Activated Carbon

OBJECTIVE: To investigate, develop, and compare innovative and novel in-place, nondestructive techniques for regenerating vapor-phase activated carbon used for air-stripping tower emissions control.

DESCRIPTION: Vapor-phase activated carbon systems are being considered for removal of the halogenated and aromatic hydrocarbons from the emissions control system. Spent activated carbon is generally reactivated using a high-temperature thermal process where the activated carbon is heated to about 1000 degrees centigrade. Many of the halogenated and aromatic hydrocarbons found in contaminated groundwater boil near 100 degrees centigrade. In-place, nondestructive methods of regenerating activated carbon could reduce the operating cost of emissions control. Steam regeneration, chemical regeneration, bioregeneration, innovative heating techniques, and other novel methods should be investigated and compared for reducing the costs of regenerating vapor-phase activated carbon.

AF89-058. TITLE: Catalytic-Additive Combustor Lining

OBJECTIVE: Develop a catalytic lining for a turbine engine combustor to decrease hydrocarbon emissions.

DESCRIPTION: Hydrocarbon emissions from jet aircraft engines are prevalent at power settings of idle and 30 percent. The concentration of hydrocarbon emissions in the exhaust decreases as the power setting is increased. At 100 percent power, the concentration of hydrocarbons is negligible. However, during ground operations, lower power settings are predominantly used and the hydrocarbons are produced in significant amounts so that ground crews and flightline support personnel are affected. Depending on local meteorological conditions, emissions from ground operations can be transported into the air handling units of nearby buildings in noticeable quantities. The design of a catalytic combustor that enhances free-radical-propagated combustion could reduce these emissions. Ceramic lined combustors are currently under development and are being tested by engine manufacturers. While many companies are pursuing this research, the main interest lies in the application of ceramic linings for increased performance and not for the reduction of emissions. The desired product is a combustor liner that minimizes the hydrocarbon emissions from a jet engine while maintaining combustor performance.

AF89-059. Title: Device for Characterizing Chemical Source Strength

OBJECTIVE: Develop an instrument that can be used to measure source strengths from chemical releases.

DESCRIPTION: Modeling accidental releases of hazardous materials requires accurate information on the volume of the material released to determine downwind concentrations. At present, the amount released can only be roughly estimated. Inaccuracies in the source emissions estimates will lead to

uncertainties in the calculation of downwind concentrations. Accurate knowledge of the source strength or emission rates will greatly enhance the accuracy and reliability of dispersion models. One recent example: the reduction in permissible exposure limits for hydrazine and hypergolic rocket propellants is driving a need for further improvements of source estimates thus ensuring the safety of people downwind from launch sites. Other hazardous chemicals of concern to the Air Force are: ammonia, chlorine, hydrogen fluoride, and hydrogen sulfide. Equipment is needed that can provide real-time measurement of chemical emission rates to improve the reliability of downwind concentration calculations for as many chemicals as possible. The required technology will have the capability to accurately measure emission rates in real-time. The technology should be intrinsically safe and provide ease of operation for field use.

AF89-060. TITLE: Passive Hydrogen Chloride (HCl) Monitors

OBJECTIVE: Develop small, inexpensive, accurate, passive sensors to quantify HCl emissions from space vehicle launches.

DESCRIPTION: Space launch vehicles generate large quantities of HCl, which is emitted into the environment. Sensors are needed that will measure HCl concentration in a range of parts-per-billion volume (ppbv) to parts-per-million (ppmv) and for times of 0.02--50 ppm-hr. Sensors should be low-cost (less than $100 each), should not require an external source of power, and should be free from interference from water and ammonia. These sensors will be deployed up to 5 miles from the launch site. They will remain unattended for up to 24 hours in the field before they are collected and analyzed.

AF89-061. TITLE: Disposal of Solid-Rocket Motors and Propellant

OBJECTIVE: Develop environmentally-safe methods to dispose of solid-rocket propellants.

DESCRIPTION: Solid rocket propellants consist of a metal fuel, an oxidizer, an an organic binder. Aluminum is usually used of as the fuel and a polymer is used as the binder. Ammonium perchlorate is almost always used as the oxidizer and when burned, it releases hydrogen chloride gas. Currently, the only method available for propellant disposal is open pit burnnng or detonation. During this procedure, the burning propellant produces a toxic and corrosive of hydrogen chloride. In addition, the propellant can deflagrate and throw pieces of unburned fuel over a large area. Because of the release of hydrogen chloride and the dispersion of unburned propellant, open pit burning is becoming an environmentally unacceptable method of disposal. In the near future, it is anticipated that open pit burning will be eliminated as the method for propellant disposal. Alternatives to open burning of propellants is important for fielding new Air Force space launch vehicles which utilize solid-rocket motors. Technology is required that will dispose of all of the ingredients from the matrix of solid rocket propellants and minimize waste from the manufacturing process.

AF89-062. TITLE: Real-Time Particle Measurement in Exhausts

OBJECTIVE: Develop real-time instrumentation to measure jet engine and rocket motor exhausts particle mass and sizes.

DESCRIPTION: Current particle sizing/mass measurements require 20 minutes to an hour of sampling time for a suitably large sample to be collected. Real-time measurement would reduce the sampling times. Aircraft and rocket particulate emissions measurement is, at this time, inadequate. No acceptable way of collecting, sizing, and analyzing particulate emissions from these courses exists. A diffusion classifier has been developed for similar sampling, but has proven to be incompatible with chain-agglomerate particulate material such as jet smoke. An electrical aerosol analyzer has been tested/adapted to extract and measure jet engine test cell exhaust, but does not directly measure soot mass. A low pressure impactor to sample jet engine exhaust has been built, but it is not a real-time monitor. Data acquisition for this instrument is very time consuming and collection substrates (greases and filter papers) are not optimum for the temperatures expected with engine and rocket exhausts. The technology that needs to be developed will transition a prototype sampling device that will allow real-time measurement of the various size classifications of particles in jet engine and rocket motor exhaust flow streams. The prototype must be able to withstand conditions of high temperature and turbulence. In addition, a computer driven data acquisition system will be integrated into the prototype design so that a turn-key system is developed.

AF89-063. TITLE: Characterization of Optical Fire Detector Stimuli

OBJECTIVE: Identify and characterize potential false alarm radiation sources at Air Force aircraft hangars to provide data for laboratory discrimination test methods.

DESCRIPTION: Many optical fire detectors in aircraft hangars are plagued with false alarms and many existing detection systems have been disabled in the field. Multiple wavelength, microprocessor-base flame radiation detectors offer better discrimination because more flame signature data is analyzed. These smart detectors cannot be accurately applied in the field because technology application information must be developed. The Phase I effort would review state-of-the-art fire detectors to determine their technological basis for fire sensing, analysis and alarming. This information would then be used to define broad-band instrumentation that would be best for performing rapid scanning of Air Force aircraft hangars to determine the active false alarm stimuli. Phase II would involve using broad-band instrumentation to survey Air Force aircraft hangars/associated operations and equipment to acquire data describing active false alarm stimuli. Threat evaluations would be performed for various hangars and these data would be analyzed to formulate mission success criteria for accurate fire detection. Laboratory methods would be identified to test the sensitivity of flame radiation detectors toward fire detection and false alarm rejection.

AF89-064. TITLE: Thermodynamics of Advanced Refrigerants

OBJECTIVE: Investigate thermodynamic characteristics of refrigerant mixtures and effects mixed refrigerants have on standard refrigeration components.

DESCRIPTION: Refrigeration equipment is designed around a specific refrigerant to be used within that equipment. Materials used for the equipment elements, as well as capacity of the equipment, are selected on the basis of achieving the best efficiency of the equipment using the selected

refrigerant. During critical situations, the ideal refrigerant may not be available to recharge a repaired air conditioning system to allow operations to resume within the affected facility. However, other non-ideal refrigerants may be available. The Phase I effort would review and analyze the impact of secondary and tertiary mixing of refrigerants on the capacity of refrigeration equipment and on the effect the mixture may have on equipment components such as seals, pumps, heat exchanger elements, etc. Mixtures to be analyzed should reflect those refrigerants, to include hydrocarbon based, that should be readily available at most Air Force bases. The Phase II effort would involve design and construction of a it and experimentally verifying the thermodynamics of the mixtures as suggested in the Phase I effort. Verification must also be made on the expected effects of the mixture of specific components of the refrigeration equipment such as seals, lubricants, valves, pumps, heat exchangers, etc.

AF89-065. TITLE: Fiber-Reinforced Spall Protection

OBJECTIVE: Develop a fiber-reinforced spall protection system for new and existing concrete structures.

DESCRIPTION: The Air Force has a need for an economical spall protection system that can be easily installed on inside walls of existing and new concrete structures. Spall, fragments of concrete flying off the inside of a wall, occurs when a wall is subjected to high impulse blast loadings as produced by conventional weapons. The blast loading applied to the front surface of the wall travels through the concrete as a compressive wave and reflects off the back wall as a tensile wave. This produces tensile stresses which exceed the low tensile strength of the concrete and localized failure occurs which produces fragments of concrete traveling at velocities in the range of 100ft/sec. The localized spalling of concrete must be contained to prevent injury and damage to personnel and equipment occupying the structure. Phase I will determine the feasibility of a fiber-reinforced spall protection system for flatwall concrete structures. Phase II should identify and evaluate loading functions and geometric responses of a protective system, identify potential system concepts and materials, and address the feasibility in a report. Phase II, if approved, should evaluate the concepts and materials identified in Phase I and develop a complete fiber-reinforced spall protection system for installation in flatwall concrete structures.

AF89-066. TITLE: Energy Fields for Fire Extinguishment

OBJECTIVE: Identify the adjustment of flames by energy fields to cause or to increase the potential for fire extinguishment.

DESCRIPTION: Burning involves changes such as the relationship of atoms, arrangements of electrons and electron clouds, states for the various energy modes, temporary formation of intermediate transition state complexes, chemical ionization reactions, and quantity of magnetic moment, to name some of the fundamental characteristics. Some of these known changes have been quantified for use in flame diagnostics. For example, the chemical ionization process which produces ions in a flame is the basis of Flame Ionization Detection for gas chromatography and radiation (laser) absorption is used to change the state of reactants during saturated fluorescence diagnostics. The Phase I effort would review, analyze, and evaluate the application of electric, magnetic, microwave, and electromagnetic energy fields for causing

or enhancing fire extinguishment. Existing applications and research of the various energy fields toward flames would be reviewed and interpreted, in relation to new efficient energy technologies (eg, superconductivity), to identify the optimal techniques for potential applications to fire extinguishment. The Phase II effort would involve the design and construction of laboratory burner apparatus to study the identified optimal energy field methods and the conduct of experiments to quantify the efficiencies of energy fields for fire extinguishment with, and without, the addition of fire extinguishing agents.

AF89-067. TITLE: System for Macro and Micro Airfield Pavement Damage Assessment

OBJECTIVE: Provide a capability for expedient and accurate contour measurement (+- 0.25 inch elevation and +- 1 inch range accuracy over a 100 ft x 100 ft surface) and 3 dimensional mapping of bomb damaged pavement.

DESCRIPTION: This method is needed for precise damage assessment in the immediate vicinity of an explosively formed crater and to permit intermittent reassessment as upheaval reduction techniques are used. For initial damage assessment on a larger scale, develop a neural network that will be able to identify the damage caused to airfield pavements in the event of attacks.

a. Time is a critical resource during rapid runway repair (RRR) minimum operating strip (MOS) selection and crater repair. Pavement upheaval is often difficult to recognize during visual inspection and current expedient measurement techniques take several minutes and are not as accurate as desired. A method/device is needed. This speed would be very helpful during MOS selection and final inspection of a finished repair, but it is critical during upheaval reduction efforts when the profile may be constantly changing. Too much upheaval reduction could result in an unacceptable sag which defeats the effort to salvage good pavement. The Phase I effort shall address system design and proposed prototype development and test plans.

b. The determination of runway damage due to an attack on an airfield presents many problems. One problem is identifying the extent of the damage. Since damage assessment may well be required at night and the environment after the attack may be highly dangerous to personnel due to the presence of biological and chemical agents, area denial mines and unexploded ordnance, it is desirable to develop an unmanned system to initially survey the airfield system for damage. One essential part of this system is the ability to quickly make an accurate assessment of the damage without endangering personnel. This can be accomplished by a system that operates autonomously with the ability to identify damage. This project would use neural network technology to develop a system using infrared imaging to identify damage to the airfield. The airfield damage includes bomb craters, spalls, unexploded ordnance, and debris. The viewing angle should be at a height of 6 feet with the option of using aerial photography.

AF89-068. TITLE: Human Systems/Subsystems Research

OBJECTIVE: To develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: This topic is intended to provide an opportunity for the proposer to submit ideas directed toward enhancing man's capability to function effecti.ely and safely as an integral part of Air Force systems and military operations with the overall objective of increasing mission success. This general area includes: human factors engineering, such as methods improving man/machine interfaces or enhancing human physical or cognitive performance; personnel protection/life support, such as life support and crew escape from a transatmospheric vehicle; chemical warfare defense, such as advanced personal and collective protective equipment; occupational/environmental hazards, such as identification of and protection of toxic materials and electromagnetic or ionizing radiations; and personnel training and simulation, such as new technologies that improve the effectiveness or efficiency of training programs and methods. Ideas are solicited that affect any or all of the operations, maintenance, and support roles of Air Force personnel. Areas of special interest include: (1) simple methods to estimate the operational manpower, personnel, and training and safety requirements of weapons systems during development; (2) the operational use/utility of robotic telepresence (sensory feedback to a human operator; particularly, flexible tactile sensing arrays for robotic hands and force reflection to the human operator of forces experienced by the robot's dexterous manipulators); and (3) equipment, systems and procedures to be used for the treatment, stabilization, and transfer of casualties during war and times of natural disaster.

AF89-069. TITLE: Real-Time Environmental Monitoring Capability

OBJECTIVE: Develop air transportable instrumentation for on-site detection, identification, and quantification of chemical contaminants.

DESCRIPTION: The Air Force needs an instrument which can rapidly detect, identify, and quantify trace levels (5 to 10 parts per billion) of chemical contaminants on personnel, and surfaces, and in soil, air, and water. The instrument must be rugged, air transportable, and capable of rapidly analyzing soil, air, and water samples. Also, it should be capable of quickly tracking (in time and space) and monitoring unknown/known chemical contaminants and should require minimum training for qualified Air Force personnel. This equipment will be used to detect environmental pollutants and chemical warfare agents. Similarly, rugged field transportable equipment capable of nonintrusively determining droplet size is also required.

a. New Environmental Protection Agency and state environmental laws have increased monitoring requirements and lowered detection limits for organic chemical contaminants, making existing real-time detection equipment obsolete. Additionally, spills/leaks of hazardous chemicals require rapid field response and evaluation to protect life and property. Rapid, innovative survey techniques and on-site chemical analyses are necessary to keep up with this growing demand. The research scheme should be: (1) evaluate emergency response capabilities of current commercially available instruments; (2) compare field analytical results with previously approved methods; and (3) develop valid on-site analytical protocols for routine Air Force chemicals.

b. In order to sustain operations in a chemical warfare environment, the Air Force needs instrumentation which can detect surface chemical agent contamination on air base personnel and equipment. The instrumentation must quickly and accurately indicate the chemical agent type, amount, and location in order to determine the need for decontamination based on the potential for injury to personnel or damage to equipment. The equipment would be used to

screen personnel in order to hasten entry into a contamination control area or toxic free area; its use must pose no hazards to personnel, including casualties with open wounds. The instrumentation will also be used to check equipment prior to loading onto aircraft or to check interiors of aircraft or buildings; it must be capable of detecting agents in cracks and crevices. In both cases, the instrumentation must be capable of detecting low levels of all threat liquid agents without responding positively to decontaminants or any chemicals normally present on air bases.

c. In order to determine age and persistence of chemical warfare agents, it is necessary to nonintrusively determine droplet size. It is not imperative that this information be real time, as accuracy is more important than response time. Droplet size measurement must be tied to at least gross analytical discrimination. Innovative concepts using hardware or software methods are sought.

d. For all three subtopics, phase I will consist of determining specific instrumentation requirements, validation testing, and selection. Phase II will include a one-year field test and final development of routine sampling methods and validation.

AF89-070. TITLE: Innovative Analysis Procedures and Equipment for Environmental Health and Drugs of Abuse

OBJECTIVE: Develop analytical procedures for environmental/occupational health pertinent materials and chemicals and drugs of abuse.

DESCRIPTION: Both the Air Force Drug Testing Laboratory (AFDTL), a high volume urinalysis drug testing facility, and the USAF Occupational and Environmental Health Laboratory's (USAFOEHL) environmental sample analysis division are interested in innovative analytical procedures. The AFDTL has a general interest in innovative analytical procedures for analyzing for the normal drugs of abuse and a specific interest in designer drug analysis. The USAFOEHL has a general interest in innovative analytical procedures for environmental chemicals and a specific interest in procedures for asbestos (i.e., fluorescent dye binding identification), hydrazine fuel in water and soil, work area solvents and airborne diisocyanates. Innovative biological monitoring procedures may be applicable to some analytical needs. In all cases the innovative analytical procedures will have to be proven to the regulating agency such as the Environmental Protection Agency or Occupational Safety and Health Administration.

Both the AFDTL and the USAFOEHL are interested in robotic technology for all aspects of their laboratory procedures, from sample receipt through results reporting. As above, the robotic procedures would have to be acceptable to the regulating agencies where applicable and forensically defensible in case of litigation.

AF89-071. TITLE: Identification and Management of Hazardous Materials in Large-Scale Systems Acquisition

OBJECTIVE: Develop innovative concepts and mechanisms for achieving effective hazardous materials management in large-scale systems acquisition.

DESCRIPTION: The proper management of hazardous materials through the life cycle of large-scale systems is a problem that needs attention in the Air Force as well as industry. There are decisions made throughout the life cycle that impact health, safety, and environmental quality. Decisions made early in the design process may well drive subsequent system design, supportability, and operability. The Air Force needs a hazardous material identification database providing information on known hazardous materials in the Air Force inventory or in development. One possibility would be to use Quantitative Structure Activity Relationships (QSAR) to predict the likelihood of hazard for chemicals not in the database. Fundamental to such a database would be the development of a systematic approach for determining the extent and kind of toxicity information which should be available on a chemical §as a function of its position in the development/cycle† and its potential uses, including prediction of possible toxic actions from QSAR considerations. A multiple volume hazardous material management guide could be developed. This guide would serve as an important reference for defense contractors, Air Force development and acquisition personnel, and occupational health personnel. An example of a successful reference work for a different application is the Air Force Installation Restoration Program Toxicology Guide. Phase I would involve definition of the concept for use, assessment of the availability of the data required for such a database, and demonstration of QSAR approaches which could be used. Phase II would involve development of an initial database and demonstration of its ability to identify known hazards and suggest potential data gaps on uncharacterized chemicals.

The Air Force needs an aid to system designers, manufacturers, and maintainers that will greatly enhance decision-making capability. Such an aid would allow better up-front exploration of system design concepts and help ensure appropriate consideration of the effect of those decisions on downstream activities such as maintenance, logistics, operation, and disposal. As an example, a material (i.e., hydraulic fluid) selected strictly on performance characteristics might produce a prohibitively large environmental impact. The decision aid must enhance the ability of system designers, developers, and maintainers to incorporate hazardous materials/devices considerations into the acquisition process in an integrated fashion, such that overall life cycle costs can be managed to acceptable criteria. Phase I research will conclude with a report that clearly defines a recommended approach and specifically addresses the merit and feasibility of that selected approach. Phase II will conclude with a working laboratory prototype and a demonstration of the developed technology.

AF89-072. TITLE: <u>Dynamic Bleaching of Protective Materials by Ultra-Short Laser Pulses</u>

OBJECTIVE: Produce methods of accurately capturing dynamic bleaching effects of single picosecond pulses on protective materials.

DESCRIPTION: Laser protective materials are designed to protect the wearer against the hazards associated with laser use. One major concern is the dynamic effects of ultra-short laser pulses on the protective abilities of the material. As a laser pulse irradiates the protective material, the protective properties of the material may decrease, making the material less effective. In other words, the laser pulse may bleach the material, thus lowering its optical density. A need exists for a programmable device which captures the dynamic bleaching effect, in terms of the shape of the laser pulse that caused it, and digitally stores the pulse shape for later analysis. The device

should have at least a 5 picosecond risetime and a vertical sensitivity ranging from 50 microvolts to 5 volts. It must have a delay line option to facilitate triggering. The device must have a dynamic range covering the most critical laser wavelengths and must have multi-channel capability. In addition to the device mentioned above, an innovative approach to capturing the bleaching effects is needed. The goal of Phase I is twofold: (a) Determine the feasibility of a device meeting the above standards and (b) Develop a programmable device which can capture, store, and process a single picosecond laser pulse and the effects of that pulse as it passes through laser protective materials.

The Phase II goal is to produce a functional, tested device meeting the above required specifications, including complete training and documentation on the proper use, configuration, and maintenance of the device.

AF89-073. TITLE: Computer Based Testing and Training in Intelligent Systems

OBJECTIVE: Develop prototype testing systems for Intelligent Tutoring System (ITS) and tools for developing of ITS by non-programmers.

DESCRIPTION: In order for ITSs to adapt to the instructional needs of individual students, ITSs must be able to diagnose skills and knowledge a student possesses at various stages of the training. Also, the successful application of artificial intelligence in training requires reductions in the time and programming expertise required to move from system concept to system prototype. This research will investigate and demonstrate enabling technologies to support rapid development of intelligent computerized applications by non-programmers. The following research areas are of interest:

a. Design Specifications for Student Model. This research would investigate the types of knowledge and skills explicated in Cognitive Psychology and Artificial Intelligence literature that are requisite for accurate assessment of an individual's capability to solve problems in a particular domain. The selection and presentation of test items would be based on the student's acquired knowledge and skills and those that have not yet been acquired.

b. Identify Psychometric Issues and Solutions in Computer Based Testing (CBT). The research would explicate the issues and implement solutions discussed in CBT literature. The issues and solutions include exposure control (selecting items from a pool of similar items so that a specific item is not presented too often), algorithms for selecting items for presentation, individual and group reports, partial scoring, multiple path solutions, techniques for presenting items (e.g., graphics, text, scrolling), and test termination criterion.

c. Design, develop, and document a prototype CBT software shell. The system should be hosted on a Zenith 248 or (80386 based) desktop computer and able to assess declarative and procedural knowledge, and problem solving skills. The CBT software should include both authoring and delivery subsystems with text and graphic interfaces.

d. This research would investigate approaches to providing non-programmers with these powerful capabilities by providing simple command languages, visually oriented programming systems, menu driven programming systems, or other approaches to developing training system interfaces.

e. This research would investigate hypertext and other innovative approaches to efficient database search, and especially the problem of providing non-programmers with the capability to create the database and related search architecture.

f. This research would investigate approaches to providing non-programmers with the capability to author device models and simulations by providing simple command languages, visually oriented programming systems, menu driven programming systems, or other approaches.

AF89-074. TITLE: Instructional Methodology for Multiship Air Combat Training

OBJECTIVE: Develop and evaluate a model methodology for team training in multiship air-to-air combat training.

DESCRIPTION: The following programs are of interest:

a. Development of a methodology (model) which accounts for the relationship and structure between individual and team training for multiship air-to-air combat training. Current approaches to training can be described as development of individual skills for specific procedural tasks at early phases with limited integrated practice of advanced multiship combat tactics at later phases. Restricted training opportunities during advanced training are the result of limited availability of simulators and training aircraft. Recent advanced, low-cost technology may afford the development of complex simulated combat environments which, in some ways, can be instructionally superior to aircraft environments because of the capability to manipulate various dimensions of training, thus overcoming some limitations in current training practice. However, a systematic training methodology is needed as a guideline to take full advantage of advanced technology. Literature on team training reviewed to date appears to offer little guidance for the development of a multiship air combat training model.

b. The goal of this effort is to develop and evaluate a team training model for multiship air combat which structures both individual and team training phases according to skill development requirements and other relevant criteria. A central issue is determination of the point (or points) in the program at which individual skills training should transition to multiship team skills training and also how programs should be structured. The research will investigate: (1) skill development hierarchies progressing from individual basic tasks thru group or team multiship combat scenarios; (2) transition from individual skill development to team skills (identification of principles which help determine points within the program at which training should transition from individual to team training methodology); (3) identification, definition, and development of performance criteria and measurement approaches for individual-to-team performance; (4) identification of methodologies which are effective for multiship training; (5) determination of the influence of team membership upon training effectiveness; (6) identification of feedback methods/media which are most effective for individual and team training situations; (7) determination of the influence of task structure and complexity upon the efficiency of team training; and (8) development and evaluation of a training model for air combat multiship training.

c. Phase I will be limited to concept formulation, literature review, and definition of research requirements for investigation of issues such as those

listed above. Recommendation from the Phase I effort will include additional issues and design requirements for development of the multiship team training model. Phase II will be devoted to the development, validation, and demonstration of a team training model.

AF89-075. TITLE: Unified Life Cycle Engineering (ULCE)

OBJECTIVE: Develop technologies for computer-aided designers to better integrate design for supportability, performance, and producibility.

DESCRIPTION: Today's computer-aided design (CAD) environment offers bench-level designers the potential to identify many supportability problems that previously remained undiscovered until much later in the acquisition process. To take advantage of this potential, the following research areas are of interest:

a. Determine and develop new reliability, availability, and maintainability applications within CAD environments that will aid designers in performing design processes or evaluating design products. Models and/or programs should be compatible with typical design phases of major weapon system acquisitions and with ongoing Reliability, Availability, and Maintainability in Computer Aided Design (RAMCAD) integration efforts.

b. Determine and develop new applications of decision science methodology that allows design engineers to trade-off various design attributes such as performance, cost, schedule, supportability, and producibility within CAD environments. Attributes may have logical measures of merit which are either qualitative or quantitative in nature, or measures of merit may have to be derived as part of decision support systems. The goal of decision models is to provide design engineers with capabilities to judge relative merits of various design options and to evaluate final designs with respect to life cycle implications.

c. Develop new methodologies and automated tools for information system design and construction which will provide data integration in an increasingly complex, heterogeneous and distributed environment. Such information systems will support the information requirements of designers as well as other functions throughout a major weapon system's life cycle. Current techniques such as IDEF 0 and IDEF 1 have proven to be too manpower and time intensive and lack the semantic richness and developmental framework required for future, large-scale, integrated information systems.

d. Determine and develop new ways of presenting information concerning human cognitive and psychomotor performance capabilities within CAD environments. Better ways of portraying large existing knowledge about human abilities developed from basic and applied research are necessary in order to develop decision rules and design criteria for use by design engineers. Meta-analysis, a technique found useful in several behavioral and social science disciplines, could prove beneficial where the knowledge base is known to be diffuse (psychomotor ability) or very dynamic (cognitive psychology).

AF89-076. TITLE: Enhanced Crew Interface Designs

OBJECTIVE: Devices and technologies which improve mission performance through enhanced design of crew interfaces to systems.

DESCRIPTION: The following projects are of interest:

a. Create new optical designs for night vision goggles. Phase I: Develop several first order optical design approaches with: Non see-through system, low weight, center of gravity close to head CG, minimum size, helmet mountable to HGU-55P, and optical port for head-up display imagery injection. Traces showing optical elements, image intensifier, and folding methods around wearer's head should be drawn for each optical design approach.

b. Investigate feasibility of a fighter attitude indicator which requires less cognitive interpretation, improves aircraft attitude situational awareness, and uses peripheral cueing so as not to interfere with display or environmental view. The mounting may be either on the helmet or in the canopy structure. The indicator must be viewable in a 180 degree horizontal field of view and 90 degree vertical field of view with reference to the pilot's design eye point. The intent is to provide visual reference cues to the pilot's central and peripheral vision areas in such a way that minimal interpretation is necessary. Phase I: Conceptual and laboratory development of the Enhanced Unusual Attitude Indicator with proof-of-concept demonstration. Phase II: A flight demonstration system for testing with an interface adaptable to US aircraft data bases and interoperability with cockpit instrumentation.

c. Determine automated custom-fit production concepts for protective equipment and clothing. Assess and integrate technology advancements made in: digitizing of human topography, computer-aided design, and automated manufacturing methods. Arrive at production concepts which can be used effectively in the DOD equipment issue environment. Phase I: State-of-the-art review and feasibility assessment. Design/production concepts for at least one piece of equipment or clothing item. Phase II: Prototype one production system. Demonstrate design and production methods for a least one item.

d. Problem: Digital Radar Landmass Simulators (DRLMS) produce conventional 525 line rate monochrome video output. Graphics engines produce 1024 by 768 or higher resolution RGB picture element imagery. Similarly, field/frame rates may differ between the two types of devices. DRLMS video must be synchronized within the graphics video (e.g., 512 x 512 within 768 x 1024) without undue degradation. Phase I: Design a video synchronization and insertion/mixing approach for combining DRLMS and graphics processor output signals. Complete engineering analysis and cost and performance estimates. Phase II: Demonstrate proof-of-concept. Government furnished equipment available at WPAFB if required. Complete drawings, schematics, parts list, and technical report of results.

AF89-077. TITLE: Crew Performance Predictions and Enhancements

OBJECTIVE: Measurement and modeling of human mental and visual capability to understand and predict performance.

DESCRIPTION: The following projects are of interest:

a. Apply neural networks to analysis of human performance in complex tasks. Problem: Measurement of human performance in piloting combat aircraft is difficult. Sensor systems measure continuous and discrete aspects of multidimensional behavior, but analysis is extremely difficult with conventional statistical methods. Near realtime predictions of workload, situational awareness, and decision behavior are not available. Phase I: State-of-the-art review, feasibility assessment, and trial application of neural networks to human performance analysis. Phase II: Prototype neural network hardware and software for predicting an important aspect of pilot performance. Demonstrate system capabilities.

b. Problem: Manned air defenses modeled using SAINT and artificial intelligence techniques are analysis-intensive and limited to restricted cases. Neural nets may require less analysis, but still maintain fidelity and robustness, allowing modeling of less limited scenarios. Phase I: Choose a neural net architecture or combination of architectures to be used for modeling. Develop methods to train the net. Identify required commercially available or custom software and computer hardware with expected cost, performance, and development schedules. Phase II: Perform proof of concept demonstration. Compare model with current modeling techniques for robustness, handling of novel inputs, and required analysis. Computer hardware and software support is available within the Human Engineering Division.

c. To provide on-line physiological assessment of pilot workload and state in aircraft and simulators. On-line monitoring of pilot state is required now and will be essential on newer aircraft and simulator systems. A physiological monitor is required which will provide on-line information and storage of information about pilot's heart rate, heart rate variability in two bands and, if possible, eye blink rate and duration information, reliable measures of operator state and workload. The device can be modular but must be capable of being worn by pilots. It should weigh no more than currently available on body recording devices and should be small. Up to eight hours of battery operation and storage capacity are required. All amplification, signal processing, and storage must be accomplished by the device. Phase I: Design and prototype development of the device. Phase II: Fabricate and test the device in actual simulation and aircraft environments.

d. Develop and demonstrate non-canonical pictorial formats for optimized cockpit information transfer. Current trends in advanced cockpit displays favor ever-increasing levels of pictorial scene fidelity. Such displays are a Visual Natural Language Interface (VNLI) for presenting the pilot with the necessary geometric relations needed for guidance, navigation, flight control, and general situational awareness. These displays often lack the static and/or dynamic sensitivity available from more conventional presentation formats. The development of an enhanced VNLI providing a synthesis of the natural geometry of the pictorial display with the enhanced sensitivity and precision of the non-pictorial format is needed. The synthesis should be accomplished via an appropriate transformation of the canonical pictorial format, and not via a simple overlay of pictorial and conventional formats. The Phase I effort will evaluate feasibility via four tasks: 1) selection of a candidate flight task and identification of associated display requirements; 2) development of one or more candidate non-canonical pictorial displays; 3) evaluation of task performance and pilot workload, via real-time pilot-in-the-

loop simulation; 4) evaluation of overall feasibility and recommendation for further development. If feasibility is demonstrated, a Phase II exploratory development effort will be supported in a full-mission simulator.

AF89-078. TITLE: Advanced Biocommunications Transducers

OBJECTIVE: Develop advanced transducers that overcome current limitations and surpass state-of-the-art devices.

DESCRIPTION: Specific transducers with enhanced performance are required to ensure effective voice communications in current and future operational systems. The following are of special interest:

a. Very Near Field Speech Measurements. Measurements of near field acoustic speech signals for use in the design of new voice transducers. Phase I: Develop approach and plan; conduct measurements on an acoustic manikin and a few subjects at existing government facilities. Phase II: Expand measurements over all American English phonemes on 50 - 100 subjects.

b. Fiber Optic Microphone. A fiber optic microphone that is resistant/insensitive to radio frequency, electromagnetic interference, and pulse. Phase I: The basic concept, analysis, and design. Phase II: Fabrication, performance demonstration, and delivery of the voice microphone.

c. Array Microphone. Multiple component, array microphone with greater speech-to-noise ratio and voice communication than current devices. Phase I: Analysis, paper design, and critical element measurements using existing government facilities. Phase II: Fabricate laboratory demonstration prototype.

d. Improved Infrared Transducers. IR transducers that expand current distance, angle of coverage, and noninterference characteristics. Phase I: Focus on improvements that include tuned reflectors and IR bandpass filters. Phase II: Apply promising transducers to a personal IR voice communication system.

e. Performance and Communications Effectiveness Task. Develop time dependent, integrated voice communication and performance task. Phase I: Analysis, hardware and software design with detailed design task analysis. Phase II: Install task in an existing government facility and verify reliability and validity of test methodology.

AF89-079. TITLE: Innovations in Aeromedical Applications

OBJECTIVE: Develop/Adapt tools, techniques, and data management methods applicable to medical determinations of flying fitness.

DESCRIPTION: USAF aircrew personnel are a unique segment of Air Force personnel in general. They are subject to special selection and retention standards broadly described as fitness to fly, which includes not only fitness across the full clinical medical and life sciences spectrum, but also issues related to flying safety. The standards are under continuous review, on one hand, to accommodate the flying stress as new aircraft/missions come on line, and on the other hand, to keep as many trained, experienced aircrew members eligible for the cockpit as possible. These reviews use data from large

databases from which prospective and epidemiologic studies can be conducted. The sources of data are the aircrew personnel themselves. A subject who has an abnormal finding in periodic flight physicals may be examined at the USAF School of Aerospace Medicine (USAFSAM). These are not typical patients encountered in clinical practice; they are younger, healthier and, for the most part, asymptomatic. Examining such patients presents unique diagnostic challenges. In addition, data are sent from all over the world to USAFSAM for consideration for individual aviation status.

AF89-080. TITLE: Chemical/Biological Defense Protection

OBJECTIVE Develop equipment and techniques for USAF forces survival and effective operation in chemical/biological toxic environment.

DESCRIPTION: The following programs provide improvements and alternatives to current USAF protective systems:

a. Both air and ground crew chemical defense gloves need to be streamlined. Current systems are bulky, need dexterity and tactile improvements, and impose thermal burden. For some tasks more durability is needed. Phase I will deal with preliminary material and/or design functions which will improve performance and maintain current levels of protection.

b. This effort is for ensemble development where the primary focus is on human performance without compromising protection. Performance domains include psychomotor, communications, infantry/security tasks, air base group tasks, flight line, and maintenance tasks at a minimum. Protection concepts should include chemical/biological, thermal hazards, and physiological status in general. Phase I is envisioned as a requirements analysis, a small design effort for demonstration purposes, and an initial identification of off-the-shelf options.

c. Needs for improvement in chemical agent filtration systems include the following: (Phase I includes a study to assess alternatives and perform initial tests).

(1) Personnel will be required to function in a toxic environment without a filter life indicator. A system or device is needed to indicate the life time expiration of a filter.

(2) Moisture degrades the performance of charcoal filters and charcoal impregnated materials. Systems or procedures to eliminate or reduce this degradation are needed.

(3) Alternatives to standard charcoal and charcoal impregnated materials are needed.

(4) Substances or procedures which reduce skin irritation from masks, gloves and other chemical defense equipment is needed.

d. Also needed are specific accessories for improving performance and safety as follows: (Phase I assesses materials, technologies and preliminary testing.)

(1) Enhanced protection through modified ventilation systems or other means will reduce the chance of exposure and contamination for vehicle operators and maintenance personnel. Systems, strategies and analyses are needed.

(2) Two-way communication for flightline personnel is impaired by chemical gear as well as flightline noise. A system is needed to enhance communication capability without compromising the protection factor.

(3) Current procedures require individuals to process into collective protection facilities for rest and relief (R&R). Strategies or systems are needed to reduce the number of inprocessing and egress cycles to or from fixed shelters, by providing portable R&R facilities for use which do not compromise protection.

(4) Develop nontoxic/noncorrosive decontamination reagents for the chemical agents decontamination. Design and develop procedures for field application of these reagents for equipment and personnel contamination problems.

(5) Develop low cost fit assessment equipment and procedures for field use for chemical protective respirators. Quantitation is required with protection factors (ratio of outside to under the mask agent concentrations) of 10,000 and better to be demonstrated.

(6) Any innovative concepts or applications of technology to improve performance or protective factor in chemical defense equipment are welcomed.

AF89-081. TITLE: Decision Aid Process for Investment Strategy

OBJECTIVE: Develop an analytic framework for quantifying benefits of research and development in human systems technologies.

DESCRIPTION: In the design, development and utilization of the hardware component of weapon systems, the concept of measuring the benefits of the systems is well founded. Objective measures exist on such factors as speed and ability to deliver a weapon payload and costs of development, manufacturing and operation can be estimated and weighed against the system's performance. However, in the conduct and delivery of human-centered research and research products, defining and measuring the benefits are much more difficult tasks. Often benefits are expressed in such terms as improved training, better job performance, or increased job satisfaction. When they are quantified, the benefits, at best, are expressed in terms of reduced costs in such areas as recruiting, training, and sustaining, or retaining the force. Very seldom is the manpower, personnel, and training research community able to make strong, positive, supportable statements about the value of its research products. The Human Systems Division is constantly faced with decisions about the proper mix of diverse research efforts including selection and classification, job restructuring and determination, decision aids and models, life support systems, toxic material evaluation, etc. These decisions allocating limited R&D resources among competing projects are greatly complicated by the inability to measure potential benefits in a manner that is equally meaningful to the different types of R&D programs.

This research would be divided into two distinct phases. Phase I of this project would review the current status of cost/benefit analysis and assess-

ment of utility/worth, concentrating on R&D project selection and benefit determination. The intent of Phase I will be to develop a model which will permit the estimation of benefits from manpower, personnel, and training R&D (areas in which it has traditionally been difficult to determine dollar values) and facilitate the comparison of such efforts with hardware-oriented R&D/engineering efforts. Relevant research and cost/benefit models from the private sector as well as other government and military studies will be reviewed. Data definitions, data availability, and alternative measures (dollars, time, etc), use of the model in allocating resources, and other factors will be considered in this phase. The contractor shall develop a prototype model which shall be used to quantify the value of two specific research projects to be selected by the contract monitor. Phase II of this effort will further develop the prototype to permit R&D managers to allocate resources across many different projects and estimate the comparable worth of each effort. An interactive cost/benefit allocation and valuation software model will be developed.

AF89-082. TITLE: Parallel Processing for Artificial Intelligence (AI) and Graphics Applications

OBJECTIVE: To modify and implement an inference engine on an existing parallel processor and/or investigate the effects of mapping graphics algorithms onto parallel architectures.

DESCRIPTION: The following programs are of specific interest:

a. Current AI types of systems are implemented as rule-based systems where facts are asserted into the knowledge-base by a portion of the system called the inference engine. This inference mechanism controls the manner in which knowledge-based systems accomplish their given task. To achieve "real-time" operation of these types of systems, this normally serial process needs to be parallelized. There are several classes of parallel processors in existence today; and as part of this effort, a trade study will be done to determine each processor's adaptability to real-time knowledge-based systems. This study will also determine which class of parallel processors will give the greatest gains in speed and performance and then determine the ability to adapt an inference engine to that processor to achieve real-time operation. Phase I should address parallel processors available under DARPA's Strategic Computing Program and determine the adaptability of each for implementing complex AI applications for avionics with the potential of achieving real-time operations. While several inference engines are based upon the Rete algorithm, there are modifications to this algorithm which attempt to improve the inherent serial nature of the algorithm. Also, part of Phase I activity should be the familiarization of algorithms used for inferencing. This should lead to Phase II activities of modifying and implementing an inferencing mechanism for a parallel processor identified in Phase I. Phase II should target an existing airborne application to show potential real-time operation as a result of this effort.

b. Currently, there exists a variety of algorithms dealing with the generation of graphics primitives. For example, Bresenham's and Digital Differential Analyzer algorithms are principally used for generating "lines" and "circles." This program will investigate the adaptability of these algorithms to parallel processing architectures. Algorithms will be investigated for each primitive as defined in the evolving PHIGS graphics standard. Phase I should examine these algorithms and determine which ones lend them-

selves, as is, to parallelism, which ones can be modified or if new algorithms need to be written. The primary metric to be used in evaluating the potential for each candidate algorithm is speed. Each algorithm will be investigated from the standpoint of its current execution speed to that which can be achieved using parallel processing techniques currently under development. If the algorithms can be modelled and executed in a parallel fashion, they will provide the software framework for use in a subsequent effort investigating the hardware requirements needed to generate complex graphics images in real time. Phase II will consist of mapping these algorithms onto an existing parallel processor. This will demonstrate the potential of parallel processing for real time graphics generation.

AF89-083. TITLE: Abductive and Inductive Reasoning Applied to Advanced Avionics System Diagnostics

OBJECTIVE: Develop and demonstrate the technology required to increase substantially the on-aircraft diagnostic capabilities of advanced avionics systems.

DESCRIPTION: Current aircraft avionics systems have false alarms and cannot duplicate rates in excess of 20 percent and retest okay rates over 30 percent. Built-in test (BIT) requirements have been steadily increasing and have become a major cost in the development of avionics systems. In addition, inaccurate and incomplete diagnostic information results in unnecessary mission aborts and can cause loss of aircraft and pilots. The increased complexity and operational and maintenance requirements of advanced weapon systems make it unlikely that the required diagnostic capability will be achieved through conventional BIT methods. To diagnose future avionics systems and reduce built-in test equipment (BITE) necessitates a capability to reason about faults at a system level in much the same manner as pilots or maintenance technicians perform diagnostics. Humans are able to cope with many of the deficiencies of current BIT systems through their ability to reason effectively about the intended design behavior of the system given system-level information that is often uncertain (unreliable, incomplete, and/or contradictory). Abductive and inductive reasoning provide the means to deal with the uncertainty and combinatorial problems, associated with performing diagnostics from system-level information and provide techniques to reason at a much "deeper" level than can be accomplished using current production rule or model-based systems.

Phase I should include a study of the diagnostic problems anticipated for advanced avionics systems, the limitations of conventional BIT and artificial intelligence approaches, and the applicability of abductive and inductive reasoning to diagnosis of advanced avionics systems. The study should also include an investigation of the relationship between abductive reasoning and reasoning from first principles. In addition, a feasibility demonstration should be performed illustrating the capability to synthesize inductively abductive models to perform diagnostics at a system level given uncertain information. Phase II should result in a prototype system and demonstration that conclusively illustrate the capability to increase fault detection and isolation, validate failure indications, and substantially reduce BITE requirements for advanced avionics using a combination of abduction and induction. Phase II should also result in the design and prototyping of a generic system for diagnosing advanced avionics systems.

AF89-084. TITLE: Integrated Information Signal Processing

OBJECTIVE: To develop and analyze innovative concepts for combining aircraft communications, navigation, and identification (CNI) functions into a single covert radio frequency (RF) anti-jam signal/waveform.

DESCRIPTION: The CNI capability desired would include some combination of voice, relative navigation, and digital data composed of target tracks, housekeeping, and electronic warfare information. This waveform will be utilized by tactical and strategic platforms. Multifunction modulations have existed for more than thirty years. The most commonly known is television, which uses single sideband amplitude modulation for luminance information, an analog phase modulated signal for color information, and a frequency modulated subcarrier for audio. A second example is the Joint Tactical Information Distribution System, which uses a frequency hopped, time hopped, pseudo-noise modulated waveform to provide a CNI capability for multiple platforms. Phase I will study and propose integrated modulation waveform concepts to provide an airborne, integrated CNI capability which has low probability of detection, low probability of interception, low probability of exploitation, and jam resistant properties. Preliminary concepts will be theoretically analyzed to determine the most feasible approach. Phase II will develop a top level system specification and vulnerability/susceptibility data for the most feasible conceptual designs developed under Phase I.

AF89-085. TITLE: Language Implications for Real-Time Artificial Intelligence (AI) Systems

OBJECTIVE: To address the issue of language (e.g., Lisp vs Ada) for AI applications for avionics with the capability of real-time operation in an embedded avionics environment.

DESCRIPTION: Many current AI approaches to avionics applications are written for laboratory-based prototype systems. These applications are written in Lisp and are hosted on an AI workstation. On the other hand, DOD has mandated that the language of choice for Air Force applications is Ada. Before we can pursue the actual implementation of AI technology into embedded avionics, we need to address the issues, such as the language, for these types of applications. Some of the language issues which need to be addressed include (1) the adaptability of Ada to large complex real-time AI applications, (2) can applications written in Lisp achieve predictable real-time operation, and (3) which language can achieve the parallelism and capability required for the operation of embedded AI systems in real time. Phase I should consist of a feasibility study addressing the issues listed above. Phase II should extend the efforts started in Phase I with the focus on an existing, or developed, AI application to address the tradeoffs between Lisp and Ada for real-time embedded avionics AI applications.

AF89-086. TITLE: Complex Integrated Circuit Technology

OBJECTIVE: To develop higher speed, higher density circuit, and interconnection techniques to address the higher throughput and reliability requirements of future aerospace systems.

DESCRIPTION: Research is needed to advance the state of the art in the area of complex monolithic integrated circuits and take maximum advantage of novel

approaches to circuit configuration and point to point interconnect. To accomplish this objective will require dedicated efforts in such areas as (1) optimized interconnect concepts which achieve high speed through enhanced conductance and controlled parasitics; (2) the use of multi-level metal and/or three dimensional structures to achieve higher functional density; (3) modeling techniques to lower the risk of accurately predicting functionality of devices, interconnect, and packaging in competitive approaches; (4) innovative packaging concepts which address power distribution and thermal management; and (5) fault tolerance and yield improvement approaches to lower final assembly costs. The above description defines a broad area of interest, and proposals addressing individual or combined areas are strongly encouraged as long as they are clearly targeted to the final objective. Phase I activity will identify the limitations of present interconnect and packaging approaches and determine those areas which offer the greatest potential for improvement. Phase II will select one or more interconnect or packaging concepts based on modeling results, demonstrate the improvement in total performance, and identify further development necessary for transition to system applications.

AF89-087. TITLE: Miniature Broadband Circulator

OBJECTIVE: To develop small broadband circulators suitable for use in solid state phased array radar and electronic warfare applications.

DESCRIPTION: System designers are investigating the use of broadband solid state arrays for radar and electronic warfare. Circulators are needed in these arrays to provide isolation between the radiating elements and the solid state transmit/receive circuits. Arrays operating at 18 GHz require a module spacing of 0.325". Circulators currently do not exist that can meet performance requirements over the 6-18 GHz band and physically fit within a 0.16" high by 0.325" wide module. The circulator length can be up to 0.75" long, if necessary; but the specified height and width are not negotiable. The subject program will investigate approaches for developing miniature circulators with less than 1dB insertion loss, a minimum of 15dB return loss, and 15dB isolation. Phase I will be limited to the development of circuit models and analysis. Phase II will include validation of the circuit approach by hardware development testing and model refinement.

AF89-088. TITLE: Holographic Lithography for Microcircuits

OBJECTIVE: To investigate holographic techniques for lithography in the fabrication of integrated circuits with submicrometer features.

DESCRIPTION: Low cost techniques are needed to form microcircuit patterns for the next generation of semiconductor devices without the use of very expensive optical lenses, electron beam machines, or X-ray machines. Optical imaging techniques for lithography of 0.3 micrometer features are near the maximum of resolution, depth of focus, field size, and homogeneity for practical wavelengths down to about 193 nanometers. Electron beam lithography machines are limited by throughput and proximity effects on exposure. X-ray lithography requires expensive machines, such as synchrotrons, and is limited by resists and the stability of masking materials.

Recent theoretical studies have indicated lensless holographic techniques may be useful for lithography. Preliminary experiments, using simple test

patterns, have shown that 0.3 micrometer features can be obtained with greater than 50 micrometers depth of field, and over a field size greater than 10 millimeters using G-line wavelengths at 436 nanometers. The feasibility as a practical lithography for integrated circuits needs to be determined. Items of concern are the limits of field size, resolution, power requirements, power distribution and uniformity, aberrations, limits on magnification/demagnification at various wavelengths down to 193 nanometers, and the cost of implementing this technique into a practical tool.

Phase I for this effort should extend the theoretical studies and experimentally determine the limits of this approach and the feasibility of a practical lithography machine for integrated circuit applications. Phase II of this effort should culminate in the fabrication of a prototype model for test and evaluation in an actual integrated circuits fabrication facility and provide for estimate of cost for a production tool.

AF89-089. TITLE: Picosecond Pulse Semiconductor Diode Laser

OBJECTIVE: Explore and develop techniques for demonstrating high energy, picosecond pulse, semiconductor lasers.

DESCRIPTION: A simple, compact, efficient, and reliable source of picosecond optical pulses is needed for optical probing of high speed circuit/device operation, optical switching, and signal processing. Typically, flowing dye lasers pumped by Nd:YAG or Arion lasers are currently used. These instruments are large, expensive, difficult to operate, and require considerable maintenance. This program will investigate techniques to develop a compact, easy to operate, low maintenance, picosecond pulse laser. The laser should be capable of stable output (low jitter in pulse timing and energy per pulse), near diffraction limited beam quality, and greater than one MHz repetition rate. In addition, the proposed technique should allow the combining of diode laser arrays for average power greater than 20 watts. The goal of Phase I is to demonstrate feasibility of key technologies in development of a picosecond pulse, semiconductor laser. The goal of Phase II is demonstration of a laser device with the potential for scaling to the 20 W average power level and the potential for commercial development.

AF89-090. TITLE: On-Chip Information Processing for Aerial Electro-Optical (EO) Sensing With FPAs

OBJECTIVE: To develop promising new techniques for increasing the reliability and rate of information processing in air-to-air EO systems utilizing focal plane arrays.

DESCRIPTION: Twenty-first century aerial EO avionics systems will merge the functions of pilotage, acquisition, tracking, identification, and warning. Whether such systems utilize full staring arrays or scanned arrays, it is likely that adequate throughput will depend on Focal Plane Array (FPA) detector chip architectures which involve some preliminary on-chip information processing. Under this topic, innovative approaches are solicited to on-FPA information processing which enhances the quality and rate of throughput of such EO systems. The product of Phase I will be a collection of techniques whose promise is illustrated with performance models and perhaps limited empirical evidence. Phase II will be a breadboard demonstration of selected techniques.

AF89-091. TITLE: <u>3-D Target Modeling, Representation, and Perception</u>

OBJECTIVE: Develop new concepts in signature modeling, geometric representation, and perception of 3-D objects.

DESCRIPTION: The following programs are of specific interest:

a. Decomposed Infrared (IR) modeling for Model-Based Vision (MBV). New approaches to IR signature modeling under transient conditions for both active (laser radar) and passive electro-optical sensors are needed which can support the following requirements: (1) explicit representation of phenomenological cause and effect to facilitate reasoning about energy exchange mechanisms between target and background and among target subcomponents; (2) prediction of target features at coarse, medium, and fine levels of resolution, accuracy, and computational complexity; (3) modeling code that is decomposed into as many separable, simple submodels as possible to support radiation signature uncertainty estimation and distributed control in the prediction process; and (4) prediction of aggregate target features (such as target subarea shape, intensity, and spatial location) as opposed to a visual rendering of the complete target (i.e., pixel based 'picture' prediction). Phase II effort will consist of a computer implementation in the government supplied Sensor Algorithm Research Expert (SAR Expert) System MBV testbed.

b. 3-D target model representation using massively parallel connectionist architectures for MBV applications. MBV approaches attempt to match observed sensor information to reference model information. This effort will explore implementation approaches for the model component of baseline serial architecture MBV approaches in advanced parallel computing environments such as neural networks for 3-D imaging applications (e.g., laser radars). Specifically, this effort will examine techniques for representing 3-D object geometry models in a distributed parallel processing environment to facilitate the process of matching sensed 3-D information with stored 3-D geometry models. Phase II effort will consist of implementation of the model representation strategy developed in Phase I directly or via simulation in a massively parallel connectionist architecture.

c. Perceptual grouping and motion analysis. The human visual system is adept at organizing local, disconnected events into coherent, meaningful global perceptions (e.g., grouping edges into curves) while under motion, itself, and while observing moving objects in a scene. Algorithmic processes to perform such groupings are sought in the context of MBV research to facilitate the process of describing the objects in the scene in terms of stored models. The perceived groupings would serve as key indicators for indexing into a stored data base of potential models for the object underlying the grouping in questions. Phase II effort will consist of a demonstration of Phase I techniques via implementation in supplied SAR Expert System MBV testbed.

AF89-092. TITLE: <u>Agile Coherent Laser Radar</u>

OBJECTIVE: To develop a diode-pumped solid state coherent laser radar, an agile electro-optic beam controller, or other novel laser radar improvement.

DESCRIPTION: Laser radar is a key technology for Air Force missions requiring a high performance sensor, for example, air-to-ground targeting, space-based strategic defense, and target recognition sensors. A solid state laser offers improvements over present CO_2 systems, both in performance due to shorter wavelength and in reliability due to elimination of gas apparatus and seals. For maximum efficiency, the laser radar should include coherent detection for the receiver and diode pumping of the solid state source. There is a need to demonstrate coherent laser radar with a diode-pumped source at output energy of at least 100mJ. Nd:YAG is the most mature technology, but holmium and thulium are of interest because of their eye-safe wavelengths. Materials with long upper-state lifetimes are also of interest because of the possibility of continuous wave diode pumping. Another possible improvement is in the beam control devices. Optical wavelengths inherently produce a narrow beam which is desirable for high angular resolution; however, the narrow beam requires precise stabilization for pointing control and rapid steering to search a target area or image with a reasonable frame time. An electronically-controlled grating written on a suitable electro-optical material could provide non-mechanical beam stabilization without gimbals and rapid optical beam steering without scanning mirrors. Candidate materials should have response times on the order of a millisecond or faster and be capable of being fabricated in aperture sizes of at least 15cm. New materials such as ferroelectric liquid crystals have the required fast response and may be suitable for this application. In this program, the contractor will develop an improvement for target-tracking laser radar. The contractor will study his proposed laser radar improvement in Phase I and define critical technology demonstrations to be carried out in Phase II.

AF89-093. TITLE: Advanced Measures of Effectiveness (MOEs) for the Strategic Relocatable Target Attack (SRTA) Mission

OBJECTIVE: Develop and evaluate a set of effectiveness measures that can be used to evaluate advanced weapon system concepts for the SRTA mission.

DESCRIPTION: A consistent and useful set of MOEs are needed to provide analysis for evaluating advanced weapon system concepts for the SRTA mission. Most MOEs used for mission analysis have been somewhat inadequate in providing relative figures of merit that satisfy the needs of the technical and operational communities simultaneously. Some recent work has improved the overall usefulness of certain MOEs. Specifically, the Damage Expectancy (DE) MOE was modified to include a cumulative Probability of Engagement (Pe) term. This term was derived from numerous target attributes, weapon system characteristics, and sensor parameters. The modification to the DE MOE permits its use in SRTA mission analyses. A second major benefit derived from the DE modification is that a MOE that originally provided operational utility now provides useful information to the technical community as well. There is still a need to provide additional modifications to the DE MOE so that advanced concepts, such as those that suggest the use of multiple targeting assets for the SRTA mission, can be evaluated. Thus, single platform concepts, which can be evaluated by the present DE modification, could be compared to advanced multiple platform concepts that require another form of the DE MOE. Phase I of this effort would be used to develop the appropriate DE and Pe methodologies and provide "best case" estimates of an advanced concept's performance. Phase II would be used to examine more detailed bomber/multiple targeting concepts and to modify or develop an appropriate simulation tool.

AF89-094. TITLE: <u>Transition and Connectivity Between Electronic Combat Digital Models and Hybrid Simulators</u>

OBJECTIVE: To develop and implement a methodology which promotes a positive transition between the effective use of Electronic Combat (EC) digital models and hybrid simulators.

DESCRIPTION: The development of modern day EC systems pose formidable challenges for: (a) the analyst to certify study accuracy early in the development cycle and (b) the test engineer to ensure system integrity prior to deployment of the system. The difficulty of these tasks increases exponentially as a function of both system complexity and threat diversity. While considerable advances have been made in the development of digital models and hybrid simulators, the uniqueness and point design nature of these tools in their present state precludes the transition of information and/or interconnection of complementary features. Since commonality between digital models and hybrid simulators is high and, in general, differs only in level of fidelity, methods to connect or transition information between complementary functions of the digital models and hybrid simulators would yield high payoff for both the analyst and test engineer. Examples include correlation between study results and test and evaluation data, standardization of threat and EC system parameters, and verification of digital model accuracy. In addition, the growing complexity of advanced power managed electronic countermeasure (ECM) systems require a level of hybrid simulator sophistication that is presently cost prohibitive. The integration of real-time digital models with hybrid simulators would enable a more cost effective solution to this problem and provide a more reconfigurable simulation. The Phase I effort will consist of concept formulation and the development of a methodology to provide an effective transition of information and improved connectivity between EC digital models and hybrid simulators. The Phase II effort will implement the methodology described by the Phase I effort by developing the necessary hardware and software, adapting existing government furnished EC digital models and hybrid simulators, and demonstrating the resulting product at the Integrated Defensive Avionics Facility in Building 620, W-PAFB OH.

AF89-095. TITLE: <u>Optical Filtering for Infrared Target Detection</u>

OBJECTIVE: To investigate clutter suppression techniques for infrared threat warning receivers.

DESCRIPTION: Tactical infrared missile warning receivers require intensive spatial, temporal, and spectral filtering of the received radiation field to permit reliable separation of targets from backgrounds and false alarm sources. Current practice is to measure the intensity from the detector array in each spectral band of interest, bring the signals out, and perform the filtering in a signal processor. The purpose of this research is to investigate ways to perform at least some of the filtering functions optically or within the detector array structure in order to improve discrimination efficiency and reduce the load on the external processing. Candidate filtering functions include (1) extracting point sources from structured background, (2) suppression of dc background radiation levels and measurement of transient events, and (3) spectral signature matching. Phase I will be an analysis of the proposed techniques against the system requirements and definition of a feasibility demonstration. Phase II will include further definition of the technique and the development of feasibility demonstration hardware.

AF89-096. TITLE: Mathematical Analysis of Linear Feedback Shift Register Sequence Generators

OBJECTIVE: To apply the shift-and-add property and other properties of linear sequences to determine the generator configuration.

DESCRIPTION: Improved reception and synchronization to wideband communication signals of unknown parameters are desired. The sequences these signals are based on can be too complex to analyze in a reasonable processing time with a physically small processor. Improved methods would allow construction of cheaper, more reliable communication links as well as enhancing jamming capabilities. However, the mathematical theory of pseudorandom sequences is not sufficiently developed to support this objective. Phase I activity will consist of mathematical research to find useful relationships between shift-and-add data and the associated sequence generators. Phase II will involve computer simulation involving analysis of sample bit streams from long sequences.

AF89-097. TITLE: Artificial Intelligence (AI) and Parallel Processing Technologies for Electronic Combat Applications

OBJECTIVE: To derive maximum benefit for electronic combat applications from advanced AI technologies and distributed parallel processing systems.

DESCRIPTION: The opportunity exists, with low to medium risk, to incorporate AI and advanced information processing techniques into electronic combat systems and attain medium to high mission payoffs. A blend of advanced AI technologies (e.g., expert systems, knowledge based systems, neural networks) and multiprocessors and distributed processing systems combined with conventional approaches is suggested. The ideal situation would be to incorporate the best features or each method to tackle a current electronic combat problem in the electronic support measures, threat identification, and/or electronic countermeasures response areas. Specific technologies should be chosen along with the specific electronic combat problem to be addressed. The system should show potential for practical application to a current or projected Air Force aircraft electronic wstems. The challenge is to derive maximum benefit from these emerging technologies and provide proof of principle with potential to transition a resulting new system or provide current system improvement for the users within the next five to fifteen years. Phase I includes assessment of electronic warfare system functional description and identification of high payoff hardware and software technologies. Phase II would result in the simulation and validation of the system/subsystem approach fostered in Phase I to the extent that further development and transition to advanced programs should be considered. Laboratory demonstrations on government integrated test beds and processors is applicable for Phase II.

AF89-098. TITLE: Low Probability of Interception (LPI) Milstar Modulator

OBJECTIVE: To study and develop a design for a modulator, which will produce a phase continuous, frequency-hopped waveform for use in Milstar terminals.

DESCRIPTION: The normal implementation of a frequency-hopping modulator results in transients which occur when switching from one frequency to

another. These transients are due to the discontinuity in the waveform during the switching period. By minimizing the transient during switching, the resulting side lobe or out-of-band energy can be significantly reduced. This would significantly reduce the probability of intercept. Milstar is a multiple access system. This approach would allow more users in a given bandwidth; and, thus, reduce the possibility of interference among the users. Various implementations will be evaluated. Considering trade-offs, one design would be selected which provides an optimum signal formation during switching. The technology derived from this effort would not only be of benefit to the Milstar program, but the LPI attributes of such a modulator would be useful in communication systems using frequency-hopping or phase modulation. This would lead to Phase II and the actual construction of a prototype modulator and demodulator.

AF89-099. TITLE: Threat Identification Error Reduction Techniques

OBJECTIVE: To investigate techniques to improve the confidence level of emitter detection and identification in electronic warfare systems.

DESCRIPTION: Current methods of processing radar warning receiver data require high quality receiver data. As the signal density increases, the percentage of missing and corrupted signals increases dramatically, causing conventional pulse-by-pulse processing techniques to falsely detect and identify emitters from the set of data as received from the radar warning receiver. The approach to be investigated for this program is to transform the digital output words from the radar warning receiver into a low level image by histogramming. The histograms are then processed using image-like algorithms. The approach provides a global view of the emitter environment and the ability to localize areas of ambiguity. These results can be compared to the results of the pulse-by-pulse processing operation using expert system analysis techniques to reduce to an acceptable level erroneous emitter detections and identifications and improve overall system performance. Phase I will address the image-like algorithms that will be required to process the histograms and to locate obvious emitters and areas of probable ambiguity. Phase II will develop a set of rules for comparing the results of Phase I with the results of other processing operations, including those of other sensors, to resolve ambiguous results and to validate threat emitter identifications. The algorithms will be developed on commercially available computers and tested at the Avionics Laboratory using Air Force owned receiver/processors.

AF89-100. TITLE: Optical Interconnects for High Temperature Superconductors

OBJECTIVE: Explore and develop techniques for optical data transfer to/from high temperature superconductor circuitry.

DESCRIPTION: Optical interconnect techniques may allow superconductive devices to be more compatible with existing electronics technology. As high temperature superconductive circuits of the future become complex, interconnection will play a significant role. Techniques to be considered include optical switching of superconductors and monitoring nonlinear interactions of an optical beam with a superconductor. Bulk, surface, and field wave coupling need to be addressed. Other possible approaches include the optical interrogation and excitation of spectroscopically sensitive atoms and radiation coupling via surface structure. The basic research activity of Phase I should include a feasibility demonstration and assessment of the potential of the

technique for further exploratory development. The Phase II development goal is the validation of the technique by the demonstration of high speed optical data transfer to/from superconductive circuitry. By the end of Phase II, the technique should be developed to the extent that transition to advanced programs can be considered.

AF89-101. TITLE: Improved Strength Carbon-Carbon Faceplate Heatshield for Phased Array Antenna Windows

OBJECTIVE: To develop and demonstrate a viable multi-dimensional reinforced carbon-carbon faceplate heatshield concept for phased array button antenna windows.

DESCRIPTION: The Air Force is studying numerous hypervelocity systems with a common requirement for phased array scanning radars with large "button"antenna windows necessary for navigation, midcourse guidance, terminal guidance, and target acquisition and tracking. Because of the large size of these antenna windows, which is dictated by the radar system's performance requirements, they will have to perform both as a structural component as well as an avionics component. Carbon-carbon is one of the leading materials for the faceplate material because of the severe aeroheating environment and structural loading these windows will experience. Current state-of-the art window concepts call for machining numerous closely spaced holes in the two-dimensional reinforced carbon-carbon for the phased array radar "buttons". This process cuts through a large number of the reinforcement fibers greatly reducing the structural capability of the material. Phase I will develop and demonstrate an innovative multi-dimensional reinforced carbon-carbon antenna window concept that minimizes or eliminates fiber cutting to provide greater structural load carrying capabilities. Phase II will scale up the concept and fully characterize its performance capabilities in preparation for subsequent advanced development.

AF89-102. TITLE: Time Domain Approach to Random Dynamic Response and Fatigue

OBJECTIVE: To simulate distributed random dynamic excitations by a time domain technique and predict fatigue life by employing a cumulative damage theory.

DESCRIPTION: The prediction of random dynamic fatigue life is based on the assumption that the structural response is adequately represented by a single mode and the peak stresses obey a Rayleigh distribution. Since most turbulent flow and aeroacoustic excitation are random in nature, the standard procedure is to infer a statistical value of stress response which can then be used to invoke the Palmgren-Miner rule for fatigue life prediction. However, this procedure becomes ineffective if the instantaneous stress response departs significantly from the underlying assumption. The fatigue life prediction has been hamstrung by the power spectral density formulation which tends to gloss over the peak stress statistics for multiple mode and nonlinear responses. To obtain a more accurate prediction, it is necessary to follow the detailed process of structural response excited by random pressure fluctuations. The ultimate goal is to simulate aeroacoustic excitations by a time domain technique and thereby calculate statistically representative response time-histories by directly integrating the equations of structural motion or other approaches. Phase I activity will include demonstration of feasibility for linear structures and structures with simple geometric nonlinearity. This

will lead to the Phase II activities of final development and verification of techniques valid for stationary and non-stationary processes and transition to advanced structural design.

AF89-103. TITLE: Landing Gear Component Design Verification and Durability Determination

OBJECTIVE: To develop methods to measure and apply landing gear component full field strain values for rapid, low cost component design verification and durability determination.

DESCRIPTION: Advanced methods, including innovative techniques and apparatus, are needed to measure and apply full field strain values for high performance landing gear components design verification and durability determinations. The methods to measure full field strain must be non contacting, require minimal surface preparation, and be usable both in a laboratory and an operational environment. The methods developed may incorporate the use of a limited number of strain gages. These methods must facilitate fast, accurate, and low cost establishment of full-field strain under various simulated or actual operating conditions. Application of the methods must result in significantly improving the reliability and confidence level for design validations and durability determinations. Optical methods such as holographic interferferometry, shearography, and speckle interferometry appear to possess the potential of being developed into acceptable methods for full-field strain measurement. For the purpose of the Phase I effort, activity will be primarily aimed at demonstration of the feasibility of advanced methods for aircraft wheel design verifications and durability determinations. This will lead to Phase II activities consisting of techniques and apparatus final development for aircraft wheel design verification and durability determination including methods validation and methods transition for application to other high performance landing gear components.

AF89-104. TITLE: Automated Design of Global Fault Detection and Isolation

OBJECTIVE: Rapidly design and redesign aircraft flight control system fault detection and isolation algorithms to adapt to control system modifications.

DESCRIPTION: Fault tolerant flight control systems compensate for damage by distributing signals and control forces and moments among available resources. Redistribution of commands is based upon information from the Fault Detection and Isolation (FDI) algorithms. A global FDI isolates failures by monitoring overall system dynamic performance. With this approach, it can also protect the flight control system from generic hardware and software failures. However, since it monitors overall system dynamics, it is sensitive to the control law form and performance. Sometimes even minor changes to the control laws will require significant change in the global FDI. Therefore, these two processes are normally done serially, as the global FDI is more difficult to change. Ideally, both the control laws and the global FDI would be designed simultaneously. At present the design of global FDI algorithms is labor-intensive and time consuming. By automating the algorithm design, the development time, cost, and risk for advanced flight control systems will be reduced. Work in Phase I should show feasibility of automating major portions of the design using either explicit or implicit FDI techniques. Explicit FDI techniques can include hypothesis testing or other parametric approaches; implicit FDI techniques can include neural networks, polynomials, or other

nonparametric approaches. Phase I should also specify the architecture of a complete software development environment. This environment should be developed in Phase II and demonstrated on one or more contemporary design and redesign problems.

AF89-105. TITLE: Computational Aerodynamic Models of Aircraft and Weapons

OBJECTIVE: To develop an Air Force-wide data base of computational aerodynamic models for aerodynamic analysis of aircraft and weapons.

DESCRIPTION: Aerodynamic analysis of U.S. Air Force aircraft and weapons is accomplished at various Air Force Systems Command Laboratories, Centers, and Product Divisions for many different purposes (e.g., performance, flight loads, airframe/weapons carriage, aircraft modifications, and test planning). Each activity obtains or develops its own computational aerodynamic model, consistent with the sophistication of the numerical aerodynamic analysis method employed (e.g., Panel, Potential, Euler, and Navier-Stokes methods). The objective of the Phase I effort is to examine in detail the development and use of computational aerodynamic models of aircraft and weapons and determine if it is feasible to organize a centralized function to obtain, develop, modify, evaluate, certify, and apply those models in an efficient way throughout the Air Force. Consideration will be given to the development of methods that enable models of varying detail, using a master model as a primary reference. The contractor shall also develop estimates of the cost to develop the data base and the potential tangible benefits of developing a centralized system. If the Phase I effort shows the required feasibility, Phase II could demonstrate the program for one or more aircraft, paving the way for subsequent adoption throughout the Air Force community.

AF89-106. TITLE: Numerical Determination of Aerodynamic Coefficients Using a Gas Hydraulic Analogy Water Table

OBJECTIVE: To investigate and develop topographic mapping techniques for surface waves of gas hydraulic analogy water table experiments.

DESCRIPTION: The development of advanced supersonic and hypersonic aerospace vehicles with predicted performance beyond today's operational fleet requires the utilization of enclosed emergency escape capsules to successfully protect the crew during emergency escape. An inexpensive opportunity to investigate escape system separation effects in terms of modified aerodynamic coefficient tables is available with the utilization of gas hydraulic analogy water table testing techniques valid from low speed conditions through approximately Mach 7. The acquisition of numerical data from such experiments would be enhanced by technical advances in the area of real time topographic mapping techniques whereby the entire water table surface would be scanned by measurement devices, i.e., sound waves, light waves, laser light stero cameras, etc., thus making digital numerical data available for computer processing of CAD color coded images for raster video animation display and hydraulic analogy data for reduction into useful aerodynamic coefficients. During Phase I, real time mapping techniques would be investigated with respect to gas hydraulic analogy water table designs and specifications developed for the mapping and display system hardware. A prototype sensing and topographical mapping display system is to be developed and shown capable of sensing water surface waves using simple key element hardware and inexpensive data display for verification. This demonstration is expected to involve available off-the-shelf components.

During Phase II, a complete gas hydraulic analogy shallow water table shall be designed, developed, fabricated, and installed complete with the three-dimensional cross-translational motion of three separate bodies relative to an analogous freestream flight direction. Testing under simulated decelerated flight is desirable.

AF89-107. TITLE: Cryocooler Technology

OBJECTIVE: To improve both spacecraft and aircraft sensor system cryocoolers by reducing input power, weight or volume, or increasing reliability.

DESCRIPTION: The Air Force requires closed cycle cryogenic coolers to cool sensor systems for spacecraft, aircraft, and missiles. Typically, these coolers are inefficient and limit the life of the systems they cool. Consequently, there is a requirement to improve cooler performance and life. We are interested in innovative methods of improving cryogenic coolers and/or individual components in closed cycle cryocoolers. The improvements should result in reduced system input power, longer system life, smaller system weight and volume, or reduced system vibration (either cooler vibration or vibration transmitted to the sensor). Concepts which may be considered are: new refrigeration cycler using the magneto caloric effect, non-moving parts components, and hybrid arrangements. Components which may be considered include: compressors, expanders, regenerators, heat exchangers, seals, or bearings. Improvements to the cryocooler-sensor interface are also of interest. Both functional design and material selection may be considered. During Phase I, concepts will be developed and feasibility will be demonstrated. A successful Phase I effort will lead to a Phase II effort to build and demonstrate the performance of the concepts designed during Phase I.

AF89-108. TITLE: Real-Time Polynomial Network Synthesis

OBJECTIVE: Develop real-time polynomial synthesis algorithms using parallel processing architectures and heuristics.

DESCRIPTION: Polynomial network synthesis algorithms have been successfully applied for many years to create real-time solutions to guidance and control problems in the form of polynomial networks for otherwise intractable problems. The synthesis of these networks, however, does not occur in real time and must be performed off-line based on simulated and/or other data. For advanced systems such as the Aerospace Plane, the Advanced Launch System and the Advanced Tactical Aircraft that must operate at extremely high probability of success, synthesis algorithms will be required on-board to periodically resynthesize the networks. Because of the number of networks and the magnitude of the data that must be processed, real-time synthesis will become a major issue in successfully implementing these algorithms on-board. Phase I should consist of the adaptation of existing polynomial network synthesis algorithms or the design of new synthesis algorithms to support real-time computation and massively parallel processing. As part of the Phase I effort, various heuristics should be explored to decrease the network synthesis time and an examination of existing parallel processing architectures should be conducted to determine the most suitable architecture(s) to pursue in Phase II. Phase II should implement a prototype of the synthesis algorithms designed in Phase I and real-time demonstration for a specified Air Force application.

AF89-109. TITLE: Vortex Flows and Their Control

OBJECTIVE: To define and experimentally quantify techniques for controlling vortex strength and breakdown.

DESCRIPTION: Vortices generated by slender fuselage forebodies, wings, and strakes are an important element in attaining high levels of fighter aircraft subsonic and transonic maneuverability. However, these vortices result in highly non-linear aerodynamic characteristics at moderate and high aircraft angles of attack. Contributing to the complexity of the flow field are vortex trajectory asymmetries, vortex breakdown, interaction of multiple vortices, and vortex wing/tail interactions. A basic understanding of the vortex flow phenomena that dominates combat aircraft maneuver performance is required. Because of the importance of vortex breakdown on aircraft high angle-of-attack performance and controllability, particular emphasis should be placed on experimental quantification of the vortex breakdown process including its dependence on Reynold's number. Similarly, the effect on breakdown of adding energy to the vortex by blowing or vortex cambered surface interaction should be experimentally explored. Phase I should include an analysis and actual experimental quantification of the flow physics occurring during vortex breakdown, and include concrete ideas for delaying vortex breakdown by blowing and interaction with cambered surfaces. Phase II should include an actual experimental quantification of the flow mechanisms that delay vortex breakdown. The pneumatic and mechanical schemes for delaying vortex breakdown, identified in the Phase I effort, should be tested in Phase II through a range of Reynolds numbers and ranked according to their effectiveness.

AF89-110. TITLE: Life-Enhancement Techniques for Fatigue Life at Elevated Temperatures

OBJECTIVE: To develop innovative concepts for life-enhancement of aerospace structures for a combination of thermal and mechanical loading conditions.

DESCRIPTION: Currently, several life-enhancement techniques for an increased crack initiation period and reduced crack growth rates are available. Such techniques include cold working, shot peening, stress rolling and interference fit. However, the beneficial effects of these techniques on life diminish in the presence of elevated temperatures. Therefore, new innovative concepts and techniques are required to increase the structural life of flight vehicles at high velocities in order to assure low mass fraction structures. Phase I effort will require demonstration of the feasibility of the proposed concept of identifying new methods for extending the time periods to fatigue crack initiation and propagation to either a repair crack size or total catastrophic failure. A follow-on potential for a Phase II effort exists to develop the hardware needed to provide improved fatigue life benefits for the new methods identified in Phase I for both existing and new aircraft. A quantitative assessment of life benefits will be made based on crack growth tests.

AF89-111. TITLE: Surface Crazing Measurement Technique for Aircraft Acrylic Plastic Transparencies

OBJECTIVE: To develop a measurement technique and preferably portable apparatus for quantifying the intensity of crazing deterioration on the surfaces of aircraft acrylic plastic transparencies.

DESCRIPTION: Manifestations of the degradation mode known as surface crazing represent the single most frequent cause for removal from service of aircraft acrylic plastic windshields and canopies. Investigations of proposed accelerated laboratory test to induce crazing on the acrylic surface of coupons cut from an aircraft transparency reveals that crazing is a function of surface tensile stress and length of time in contact with a chemical reagent with only the time to incipience of crazing being noted in the test. It is a goal to establish a relationship between the time to reach a given degree of crazing in the laboratory and the time to reach an equivalent degree of crazing of the same transparency surface in operational service. Also, no known, preferably portable, technique has been demonstrated that will produce a quantitative measurement of crazing in acrylic plastics on a scale which orders the various varieties of crazing with respect to their negative impact on the optical performance of the transparency. Such a measurement technique and implementation in a portable configuration is desired in order to validate the accelerated crazing test and thus give the Air Force a decision tool for buying aircraft transparencies based on their cost per year of service life. Some principles that have been suggested for measuring crazing are based on light or surface acoustic wave transmission, reflection or scattering. These techniques remain to be implemented and proven. Phase I should demonstrate feasibility and validity in a laboratory setting. Phase II should develop a portable production prototype to be demonstrated in an operational environment.

AF89-112. TITLE: Cockpit Situational Awareness - Flight Experiment Design

OBJECTIVE: To design and conduct flight test experiments to determine the causes of pilot disorientation in Head Up Display equipped single seat fighter aircraft.

DESCRIPTION: The U.S. and Allied Air Forces are experiencing the loss of many single seat fighter aircraft due to what is believed to be pilot disorientation. Conferences have been held, ground simulations conducted, and results published, but as yet, no in-flight experiments have been performed to verify the causes and solutions to this problem. The Air Force has now instrumented a T-38 aircraft with an F-16 Head Up Display and associated equipments and will be conducting in-flight experiments in an attempt to verify the causes and evaluate proposed solutions to pilot disorientation. It will be the task of this SBIR effort to design innovative flight test experiments in Phase I and to conduct those experiments, reduce data, and document the results in Phase II.

AF89-113. TITLE: Methodology Development for Verification of Flight Critical Systems Software

OBJECTIVE: To develop and evaluate an integrated software development environment which focuses on the generation and test of software for highly coupled flight critical system applications.

DESCRIPTION: Advanced methods to enable the synthesis, development and test of software for highly integrated flight critical systems, such as a vehicle management system (VMS), are needed where fault tolerance and flight safety are major driving factors. The VMS type system is characterized by the integration of flight and propulsion controls with mission avionics functions and includes the integration of utility functions such as electrical power,

environmental controls, fuel management, and hydraulics. A development environment is required to cope with the complexities of such systems with emphasis in the areas of requirements specification, synchronization and timing, logic validation, complexity metrics, and automated testing. Phase I will provide the design of the environment and identification of available tools and additional tools which need either development or enhancement. The Phase II activities will enhance or develop needed tools and integrate the tools into an environment feasibility demonstration using a suitable baseline system for comparison. The feasibility demonstration will lead to the transition of the environment to an advanced development program for demonstration and engineering refinement, if required.

AF89-114. TITLE: Fatigue Crack Growth Retardation/Acceleration Effects in Elevated Temperature Environments

OBJECTIVE: To develop analytical techniques for modeling crack growth behavior during overloads and underloads in elevated temperature environments.

DESCRIPTION: Advanced aerospace vehicles encounter thermo-mechanical loads due to aerodynamic heating. Since these vehicles require low mass fraction for their mission performance, the durability and damage tolerance become increasingly important areas of structural concern. The airframe structures experience tensile overloads, compressive underloads, and combinations of overloads and underloads in addition to cyclic fatigue and variable temperatures. Such environmental and loading conditions affect the crack growth behavior of an existing crack in a structure. Current empirical techniques do not satisfactorily account for these effects. Most importantly, a technique for fatigue crack growth modeling for retardation and acceleration effects in a thermal-mechanical environment does not exist. The Phase I effort for this program will involve the development and demonstration of the predictive capability of such a new technique. The Phase II program will emphasize model verification and correlation with experimental crack growth data under flight simulated (thermal-mechanical) loads. The end product will be a software package for predicting fatigue crack growth behavior that accounts for the effects of crack growth retardation and acceleration.

AF89-115. TITLE: Two-Phase Fluid Heat Transfer at Low and High Accelerations

OBJECTIVE: To develop methods for predicting two-phase fluid flow regimes, pressure gradients, and heat transfer rates during boiling, condensation, and adiabatic flow in zero-gravity and high acceleration environments.

DESCRIPTION: Hypervelocity aerospace vehicles and future satellites operating at high power levels for surveillance and other defense missions will require use of circulating fluid systems for heat transfer/thermal control functions and propellant transfer. Use of two-phase fluids with evaporation at heat sources and condensation at heat sinks will provide effective and efficient transport capabilities. Cryogenic and normal temperature fluids will be involved for specific applications. However, data from ground testing of these systems must be translated into expected flight conditions for accurate prediction of operating parameters. Spacecraft and aerospace vehicle fluid heat transfer systems require additional work to predict flow regime boundaries, pressure gradients, and heat transfer rates. Equal density, immiscible liquids can simulate micro-gravity liquid-vapor flow conditions when the liquids are properly selected and data properly presented. In addition to this

approach, careful analyses and possible experiments are needed to determine micro-gravity and acceleration effects on void-quality relations and the boundaries of flow boiling regimes in both cryogenic and higher temperature systems. Further development is also needed to control flow regimes in components such as heat exchangers, evaporators, and condensers. Methods to suppress flow instabilities must be evaluated and well understood for the intended applications. Determination of feasible methods and approaches in Phase I efforts could provide a basis for Phase II work which may include design and fabrication of experimental packages for future space or aircraft flight testing.

AF89-116. TITLE: Abductive and Inductive Reasoning Applied to Intelligent Missile Defense

OBJECTIVE: Develop and demonstrate decision models that recommend optimum responses to single and multiple missile threats in real time.

DESCRIPTION: There are numerous factors associated with determining the optimum missile evasion maneuver and/or electronic countermeasures for various missile attacks. Many of these factors involve substantial uncertainty because of the variability of the factors and the limits of sensor and processing capabilities. Conventional approaches such as the use of look-up tables and/or decision trees necessitate numerous assumptions and simplification to cope with the uncertainties and the number of possible combinations of factors. These simplifications and assumptions may result in adequate laboratory systems that have limited applicability in the real world. Abductive and inductive reasoning methods offer an approach to dealing effectively with combinatorial problems, including linear and nonlinear interactions between a large number of factors, and uncertainty. The primary inductive modeling method of interest is neural network synthesis. The Phase I effort should demonstrate the application of a neural network synthesis algorithm to generating evasive maneuver decision models from a data base of sample scenarios. The training base can be generated based on surveys of experienced pilots and/or from an Air Force provided data base of simulated engagements. The Phase I effort should illustrate the ability of neural networks to deal with the combinatorial, multivariate interaction, and uncertainty problems associated with intelligent missile defense. The Phase II effort should result in a prototype capable of addressing both single and multiple missile attacks using a combination of evasive maneuvers and electronic countermeasures.

AF89-117. TITLE: Mobile Autonomous Robot Simulation (MARS) - Second Generation

OBJECTIVE: Improve existing MARS by incorporating creation of irregular shaped obstacles, enabling the use of different algorithms for robot exploration and incorporating real sensors data.

DESCRIPTION: The existing MARS includes generation of regular shaped obstacles in a two-dimensional work space, and uses an ever increasing spiral path to explore until it finds some obstacle before moving sideways to clear the obstruction and then continue its spiral path again. This has an ideal sensor at the present time. To develop the second generation of MARS, the natural progression will be to enhance the capability to create irregular shaped obstacles, incorporate other algorithms for space exploration, and use

real sensor feedback data. This will result in the next generation of MARS platform. The present MARS is compatible with Digital Microvax II and requires over 40 MB of memory. The Phase I effort will incorporate irregular shaped objects, develop alternate algorithms for exploration in the robot work space, and incorporate real sensor data. The Phase II effort will involve three-dimensional objects, incorporate additional sensor data, and provide the interface with user supplied algorithms and sensor data.

AF89-118. TITLE: Mission-Oriented Flying Qualities

OBJECTIVE: To develop aircraft flying qualities design parameters and criteria which directly reflect the requirements of specific missions.

DESCRIPTION: MIL-STD-1797 and MIL-F-8785C (Flying Qualities for Piloted Vehicles) contain the flying qualities requirements presently used by the Air Force. These requirements are defined by measurable characteristics (parameters) and bounded by criteria. The present standard does not differentiate between similar tasks, for example, air-to-air gunning and bombing. This effort will develop new flying qualities parameters/criteria which are optimal for specific fighter tasks. As a minimum, the following missions shall be addressed: low-altitude bombing to achieve precise solutions quickly and low-altitude automatic flight control operation addressing pilot adjustment of automatic inputs, pilot override of automatic systems, and system disengagement transients. Ride qualities in this environment should also be considered. Phase I activity will identify the critical missions and the flying qualities parameters which impact mission performance capability. This will lead to Phase II work directed toward developing the corresponding criteria, validation and incorporation into future revisions of the flying qualities standard and handbook. The work will be analytic in nature but will require extensive ground-based simulation with additional future in-flight simulation validation.

AF89-119. TITLE: Attachment Techniques for High Temperature Strain

OBJECTIVE: To characterize strain sensor attachment techniques on metallic and composite structural materials in elevated temperature environments.

DESCRIPTION: New transducers for strain measurement at elevated temperatures are being developed. Investigations of sensor attachment techniques are needed to determine adhesive qualities, strain transfer capability, and failure modes as a function of temperature under tensile and compressive loading. Emphasis will be placed on the testing of small samples. Typical material systems include titanium aluminides, nickel aluminides, ceramic matrix composites, and metal matrix composites. Phase I activity will include demonstration of feasibility of various strain measurement sensors and compatibility with selected materials. This will lead to Phase II activities of investigative tests of various attachment techniques on a variety of materials used for advanced structures for aerospace applications.

AF89-120. TITLE: New High Performance Polymers

OBJECTIVE: To investigate the synthesis, characterization, morphology, processing and properties of new polymer systems.

DESCRIPTION: Investigations are sought to discover new polymeric materials with potential for the development of improved structural materials, nonlinear optical materials or conductive materials. Polymer systems with exceptionally high use temperatures and reasonably low processing requirements are of primary interest. Areas of investigation to be addressed include: (a) synthesis routes and methods to improve processing of rigid-rod polymer molecular composites which give rise to very thermally stable (600 deg F to 700 deg F use temperatures) structural materials under reasonable processing conditions and without the evolution of impractical quantities of volatiles, (b) theoretical chemistry to provide fundamental understanding of the molecular requirements for achieving nonlinear optical or conductive properties in organic and semiorganic polymer systems, (c) processing, morphology and mechanics of rigid-rod polymers to discover approaches for achieving superior compressive strengths, and (d) polymer structure-property correlations to elucidate processing options for achieving desired morphologies and mechanical properties in (a) through (c) above. The establishment of viable approaches to obtaining improved nonmetallic materials are sought in Phase I efforts which can be pursued in Phase II follow-on efforts to establish their merits.

AF89-121. TITLE: Modeling of Stresses in Coated Solids

OBJECTIVE: Develop methods for assessing and understanding the behavior of solid lubricant coatings and their interaction with substrate surfaces.

DESCRIPTION: The Air Force is initiating a fundamentals oriented program in tribology with emphasis on novel deposition techniques of thin lubricating films on solid substrate surfaces. The primary purpose of this program is to enhance the understanding of tribological phenomena of surface interactions and behavior of the thin lubricating films. One are related to these studies which requires investigation and greater understanding is the role of stresses within the thin coatings. Under extreme operating environments, favorable friction and wear behavior between two interacting solids is often achieved by applying one or more costings of suitable materials to the mating surfaces. Since bulk properties of coating materials are generally quite different in comparison to those of the substrate, the design of a substrate-coating system is dependent on realistic modeling of stresses in the coatings as a function of the prescribed operating conditions. For a prescribed temperature field and boundary loading on the surface, analytical models to predict the following are currently needed: Stress distribution in coatings; Stresses at the interfaces between the coatings and between coating substrate; Thermal stresses introduced by the difference in thermal coefficient of expansion of the coating and substrate materials; Adhesion and "break away" stresses between the coating and substrate; Fatigue or endurance limits of the coatings when cyclic stress are imposed on the surface. Aside from design of coated solids, in forms of coating thicknesses and application techniques, the predictive strengths of the models will play a vital role in materials selection and screening. Thus, in addition to the design of current applications, these models should offer substantial guidance for materials development for advanced systems application in the future. Phase I goals include feasibility demonstration and approaches for establishing mathematical computer models for stresses in coatings on solid substrates. Phase II goals are to fully develop the models, apply them to actual coatings and validate the models with stress data taken from experiments performed on both metal and ceramic substrate materials.

AF89-122. TITLE: High Performance Carbon-Carbon Composites for Advance Applications

OBJECTIVE: Development of high strength, oxidation resistant carbon-carbon composites for advanced applications at temperatures from 1000 deg F to 4000 deg F.

DESCRIPTION: A variety of future Air Force systems such as high performance turbine engines and multimission hypersonic vehicles will require lightweight, structural materials that operate in the 1000 deg F-4000 deg F temperature range. Advanced fiber reinforced composites are ideal for these applications due to their high specific properties and flexibility in tailoring composite and laminate design. Carbon-carbon composites have excellent mechanical and thermal properties at elevated temperatures, but require oxidation protection at elevated temperatures. Innovative and unique ideas are sought on advanced carbon-carbon composites in the following subject areas: 1) Unique oxidation protection methods for carbon-carbon composites such as tough, low Coefficient of Thermal Expansion (CTE) coatings, or molecular/finely dispersed inhibition. 2) Analytical methods for mechanical/thermal property estimation or oxidation resistance determination. 3) Ultra high strength, thermally stable greater than 500 ksi, up to 4000 deg F use temperatures graphite fiber development. 4) Fabrication and processing of thin (less than 0.1 inch), structural carbon-carbon composites. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II goals of enhanced evaluation of Phase I concepts and additional refinement to yield optimized concepts would be followed by trade and design studies for future efforts.

AF89-123. TITLE: High Temperature Materials for Advanced Systems

OBJECTIVE: To develop, characterize, test and/or evaluate the performance of advanced high temperature structural materials for Air Force needs.

DESCRIPTION: New approaches to the development and characterization of advanced high temperature (2500 deg F-4000 deg F) structural ceramic composites, and advanced high temperature (2000 deg F-3000 deg F) structural intermetallic materials and composites, are needed for potential Air Force applications in advanced gas turbine engines and advanced transatmospheric flight vehicles. New, unique high temperature matrix/reinforcement materials, configurations and oxidation protection systems must be developed, and evaluations conducted to determine matrix/reinforcement interactions during manufacture and during application of composites. Test systems must be developed and applied for use with small samples to determine mechanical and physical behavior, such as failure modes, crack and void growth, oxidation, stress strain and cyclic stress-strain behavior as a function of temperature and loading histories. Modelling mechanical and physical behavior in terms of composite constituent materials must be implemented, and applied to prediction of mechanical behavior, failure characteristics, and response to environmental exposure of structural concepts for potential application in future advanced system designs. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would develop and refine those feasible concepts to the point where an assessment could be made of ultimate potential to help meet Air Force advanced materials needs.

AF89-124. TITLE: High Performance Light Metal Alloys and Metal Matrix Composites

OBJECTIVE: Develop improved light metal alloys based on the Aluminum, Beryllium, Titanium, and Magnesium systems.

DESCRIPTION: Unique approaches which result in new aluminum, beryllium (Be), magnesium (Mg) and titanium alloys are required to support the technology/ system requirements identified in the Air Force Systems Command Forecast II study. Incorporated are ultra high temperature aluminum alloys to replace titanium for applications to 900 deg F and ultra high temperature titanium alloys to replace superalloy applications to 1800 deg F. Environmentally stable, ultra light magnesium and beryllium alloys are also desired. Included is the response of all alloys to secondary processing. Titanium alloy requirements are directed for improvements in three areas: temperature stability to 1800 deg F, strength to 210 ksi, and high modulus/density ratio. Research is now needed to explore property improvements, especially in the corrosion resistance of Mg alloys. Improvements in strength, stiffness, and a reduction in density may be possible using novel alloying additions. Metal matrix composites (MMC) offer considerable promise for aerospace applications because of their strength to density ratio and potential use at high temperatures. Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Matrix materials considered should take advantage of unique property improvements available through MMC. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would optimize chemistry and processing and also produce larger amounts of material for a full spectrum of mechanical property evaluation. It would also include preliminary evaluation of trade and design studies to give an early indication of future application potential.

AF89-125. TITLE: Improved Nondestructive Evaluation

OBJECTIVE: Identify and evaluate new nondestructive evaluation techniques for advanced aerospace applications.

DESCRIPTION: Advanced, innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection and characterization of flaws in airframe and engine materials, including metals and metal-matrix and ceramic-matrix composites, and for use in the real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed for the detection and characterization of bulk and surface defects in both metallic and nonmetallic structures, for the evaluation of the integrity of bondlines in structures containing adhesives and metal-metal bonds, for the determination of the condition of matrix and reinforcing substructures in advanced composite structures, for the quality of high-temperature material coatings, and for the inspection electronic device materials and components. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and field inspections or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the potential for ultimate use in realistic manufacturing or in-service environments. Phase I of this program would address the initial formulation, fabrication, and evaluation of specific NDE techniques for demonstration of proof of concept. Phase II would perform enhanced devel-

opment which would include equipment or software development for optimization and demonstration of the advanced NDE techniques investigated in Phase I.

AF89-126. TITLE: Nonlinear Optical Materials

OBJECTIVE: To demonstrate approaches for obtaining materials with large nonlinear optical coefficients in useful configurations.

DESCRIPTION: Nonlinear optical materials are required for a variety of potential Air Force applications including optical switching (e.g., switches, limiters and attenuators) as well as optical data processing (e.g., spatial light modulators, frequency shifters and guided wave optics). Proposed material studies should include data and discussion showing potential for improving some currently available set of properties relevant to the appropriate application in a submicrosecond time range. Approaches applicable to inorganic and organic materials will be given consideration both in thin films and bulk media. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would perform optimization of the device(s) and material(s) that show the most promise in order to promote rapid development.

AF89-127. TITLE: High Temperature Superconducting Materials

OBJECTIVE: Development of high temperature superconducting thin film materials that can be used for sensing and modifying electromagnetic radiation.

DESCRIPTION: The recently discovered high temperature superconducting ceramic (HTSC) materials offer a variety of application opportunities. Detection of infrared (IR) radiation can potentially be improved through the use of these HTSC materials. For example, sensitivity, operating temperature, and signal processing speed are functions that need to be increased over present technology. The properties of the materials must be established and detection techniques evaluated (e.g., bolometers and Josephson junctions) in order to fully assess their value in electromagnetic sensing. Work including modeling of the superconducting mechanisms, phase diagram studies, development of unique thin film processing methods, opto-electronic response and temperature dependent noise measurements, thermal conductivity and heat capacity analyses, and electrical and magnetic measurements are examples of topics considered appropriate for this program area. Phase I would address application requirements and goals as well as initial formulation, fabrication, and evaluation specific subjects for proof of concept. Phase II would explore in depth the approach identified as most feasible in Phase I and carry out design and trade-off studies. This will include comparison to present semiconductor-based detection technology.

AF89-128. TITLE: Ultrastructured Materials

OBJECTIVE: Development of improved processes to fabricate ultrastructured materials for electronic and optical applications.

DESCRIPTION: Ultrastructured materials describes a broad technology area where the unifying theme is control of chemical composition or spatial order

at or near the atomic level, in the range of 10 nanometers or less, thereby obtaining dramatic improvements in desirable materials properties. Emphasis of this task is on semiconductors, but other "electronic" and "optical" materials will be considered. Development of improved processes to fabricate ultrastructures is within the program scope. Possible processes include atomic layer epitaxy, ion cluster beam deposition, pulse laser evaporation (laser assisted deposition), metal organic chemical vapor deposition and molecular beam epitaxy. New and/or novel techniques will also be considered. Processes for fabricating improved electronic and optical materials for solid state high frequency microwave, infrared detection, and optical signal processing, and nonlinear optical materials, are of high interest. Process modeling development applications are considered appropriate for this program area. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II goals include enhanced development of ultrastructured material fabrication and characterization technques formulated in Phase I. Phase II programs will optimize prototype systems to show potential for commercialization.

AF89-129. TITLE: Aircraft Accident Investigation Techniques for Electronic and Electrical Systems

OBJECTIVE: Establish techniques to identify failure causes of electronic/ electrical systems involved in aircraft accidents.

DESCRIPTION: The increasing reliance of aircraft on electronics has resulted in these systems being prime candidates for contributing to aircraft accidents. These systems typically are in poor condition after an accident due to impact damage and/or exposure to intense fires. The ability to discriminate post-accident damage from possible system failures contributing to the accident will aid investigators in establishing accident causes. It is expected that data will be collected to develop approaches and investigation techniques for electronic and electrical related aircraft accidents. Areas which are of particular interest include wiring failures which may be masked by post-accident arcing or damage, evaluating printed wiring boards and components that have been exposed to post-accident conditions, and evaluation instruments and display panels (lamps) for pre-accident states. Phase I activity will collect data to develop approaches and investigation techniques for electronic and electrical related aircraft accidents. This will lead to Phase II activities which will result in a handbook that provides specific examples and interpretation of findings. Special failure modes and how they can be distinguished from post accident damage should be addressed in the handbook.

AF89-130. TITLE: Metallic Adhesives for Structural Composites

OBJECTIVE: To demonstrate the use of metal alloy adhesives in the joining of heat resistant composite materials for use in the 350 deg F to 1500 deg F service temperature range.

DESCRIPTION: Polymer base structural adhesives for use in the 350deg F to 1500 deg F service temperature range suffer from lack of toughness (low peel strength and poor resistance to flaw propagation) and very difficult processability. Polymer base high performance structural adhesives for use above 600 deg F for any length of time in air presently do not exist. Preliminary work

with polybenzimideazole (PBI) carbon fiber composites and carbon/carbon composites has shown that metallic alloys formulated to melt, flow and wet these composites can form structural adhesive bonds, far stronger that the interlaminar shear strength of the composites, even at temperatures approaching the melting point of the metallic adhesive. Work needs to be accomplished to develop and demonstrate a bonding system based on metallic alloy materials, organic and carbon base adherent pretreatments (including metal priming or infiltration) and processing conditions required to produce bonds having reproducible mechanical properties. Phase I activity will include demonstration of feasibility through melting studies involving the composites and adhesives of interest and candidate surface modification treatment for the composites. Success here will lead to Phase II activities for optimization of adhesives, surface preparations and processes as well as engineering test and evaluation prototype bonded joint.

AF89-131. TITLE: Contactless Electrical Testing

OBJECTIVE: Develop techniques for probing complex integrated circuits (IC) without physical contact.

DESCRIPTION: Complex very large scale integrated (VLSI) circuits presently contain several hundred thousand transistors and very soon will contain millions of transistors. In general, signals on internal nodes can be measured by using mechanical probes. This straight forward technique has two drawbacks. First, we cannot locate probes on lines with dimensions of 1 micron or less. Second, if the probes make contact they load the circuit capacitively, resulting in false measurements and possible temporary malfunction of the integrated circuit (IC). Techniques utilizing voltage contrast and electron beam induced currents must be developed so that contactless electrical testing of complex ICs may be accomplished. These procedures are applied on the Scanning Electron Microscope (SEM) with electrical feedthroughs to the device under test. Phase I activity will include connecting the VLSI chip into a circuit so that the chip may be viewed in the SEM. Phase II activities will include development of voltage contrast, electron beam induced current (EBIC), and timing techniques for IC characterization.

AF89-132. TITLE: Unified Life-Cycle Engineering Design Aid

OBJECTIVE: To develop a design optimization aid which autonomously interacts with a feature-based modeling system to analyze and synthesize optimal or near optimal designs of mechanical parts.

DESCRIPTION: The design of most real-life (in lieu of idealized academic problems) engineering systems is characterized by the following descriptive sentences: The problems are multi-leveled, multi-dimensional and multi-disciplinary in nature. Most of the problems are loosely defined, open-ended, virtually none of which has a singular, unique solution, but all of which must be solved. The solutions are less than optimal and are called satisficing solutions. There are multiple measures of merit for judging the "goodness" of the design, all of which may not be equally important. All information required may not be available. Some information may be hard, that is, based, on scientific principles and some information may be soft, being based on designer's judgement and experience.

The ultimate engineering scheme must be based on life-cycle considerations to include both the "process-of-design" and the many "disciplines" which must be invoked during the process. The goal of life-cycle enineering is to design "optimum" or "near-optimum" systems. Optimum is defined as a design that is feasible and also superior to a number of other feasible alternative designs. A superior design can be obtained in two ways: By an iterative process or by solving an optimization problem. The Phase I goal is the investigation of new advanced computer technology as applied to the design process. The result of Phase I will be a report. Phase II will focus on the development of a system for demonstration with metrics for showing ULCE performance improvement.

AF89-133. TITLE: Low Cost Composite Structures Fabrication

OBJECTIVE: To reduce the cost to fabricate thermoset composite structures by 30% while maintaining or improving present quality levels.

DESCRIPTION: Research is desired on innovative, low cost methods and approaches to the automated fabrication of thermoset airplane composite primary and secondary structures. Present composite structures produced by the current level of fabrication automation exhibit fly away costs of 20-30% greater than conventional aluminum structures, but are required in today's systems due to their reduced weight and improved performance. Phase I of this effort should identify fabrication concepts which offer significant improvement over current practices and reduce both the cost to fabricate and attendant in-process and final part quality control and inspection. Phase II should demonstrate a preferred concept on a laboratory scale against simple structural concepts.

AF89-134. TITLE: Common Memory Data Processor

OBJECTIVE: Automatically resolve and process data to applications requiring the data regardless of the data source.

DESCRIPTION: Data Base management machines have increased the user's ability to store and retrieve data faster. This advancement in technology has not solved the inherent data management problems of accuracy, quality and uncontrolled duplication of data. This effort should explore the use of Data Base Machines for processing "common memory data" and the administration of common data. The state management of data as it is processed through the business enterprise is not well understood and requires this research. The developer should demonstrate the *Common Memory Data Processor* technology using parallel processing technology attached to an open systems interconnection (OSI) network to provide the independence and widest possible application support for engineering and manufacturing. Phase I goals will be to establish the CDMP requirements, establish conceptual alternative design, and to conduct a feasibility demonstration of the concept. The anticipated Phase II goals will include demonstrations and a technology transfer plan and business strategy with partnerships.

AF89-135. TITLE: Biotechnology for Aerospace Materials Requirements

OBJECTIVE: Apply biotechnology to obtain improved materials design concepts, useful materials with structural complexity not otherwise obtainable, and lower cost methods of materials preparation or removal.

DESCRIPTION: The Air Force is interested in research and development directed toward the following potential applications of biotechnology to aerospace materials requirements: (a) Modeling the chemical or morphological design of natural systems with structural applications such as fiber reinforced composites which might provide optimization of strength, stiffness, toughness, and weight, and subsequent reproduction of the designs using high temperature resistant chemistry. (b) Utilization of materials with chemical and morphological structures of a complexity obtainable practically only from natural sources for aerospace application requiring specific properties. Examples would include carbon matrix composite precursors with high char yields, ceramic precursors, and materials with nonlinear optical or electromagnetic properties. (c) Biological preparation methods for aerospace materials, which might include the biosynthesis of chemical intermediates for matrix resins for organic matrix resin composites, ceramic materials, lubricants, elastomeric materials, electro-optical materials, etc. This area also might include bioleaching or bioaccumulation for obtaining or purifying rare metals for aerospace applications. (d) The use of biodegradative methods for the removal of materials such as sealants and paint or other coatings from aircraft, or for integrated circuit etching. Phase I would address application requirements and goals as well as initial formulation, fabrication, and evaluation required for proof of concept. In Phase II, the process or design concepts from Phase I would be developed through optimization and scale-up efforts in order to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product for Phase III.

AF89-136. TITLE: Phenomenology & Effects of Materials/Laser Interactions

OBJECTIVE: To analyze, model and experimentally characterize known/new properties under laser irradiation.

DESCRIPTION: Understanding of the interaction phenomenology and effects of continuous-wave and repetitively-pulsed laser radiation on materials is required for development of survivable systems. Basic material properties and responses that vary as a function of wavelength, temperature, heating rate and other parameters are critical to that understanding. Emphasis will be placed on basic irradiation-effects experimentation, theory and modeling, innovative target and beam diagnostic development and attempts to develop unusual methods to counter laser radiation damage. Materials of interest include: innovative materials, composites and structures, in-situ processed high temperature materials, carbon-carbide materials coatings and thin films, and detectors subelements. Phase I activity includes demonstration of feasibility, whether experimental or theoretical. Phase II efforts will usually lead to a validated process or product with market/inherent potential for the DOD; although such process or product need not be fully developed but must, at least, fully demonstrate its principle. Proposal inputs are to be unclassified.

AF89-137. TITLE: Epistemic Planning for Management and Manufacturing

OBJECTIVE: To develop a logical theory and computational model for multi-agent reasoning about various epistemic, modal and intensional concepts needed to model management and manufacturing operations.

DESCRIPTION: Most automated systems, with few exceptions have not attempted to deal with multiple agents with multiple epistemic states. Worse, most

automated systems require detailed specifications as to the preconditions and results of actions. These restrictions are clearly intolerable in a management or manufacturing enterprise where one is dealing with thousands of employees, each with his own epistemic states, and with thousands of potential actions that may be performed concurrently or in an overlapped manner. Consider the following three actions: A manager orders and employee to make a part; the employee makes the part and then reports to the manager that the part is made. Initially, the manager's goal is to make the part. After the order is given this goal becomes the employee's goal and the manager has the expectation that the part will be made. After the employee makes the part, the employee has the belief that the part was made, and when this belief is reported to the manager it becomes the manager's belief. Unfortunately, these fairly obvious descriptions of the consequences of these actions do not explain a number of subtleties; such as why the manager should continue to expect that the part is being made during and after the period in which it was made, as this was not explicitly stated as a result of making that part, and also as to why the manager no longer has the goal of making the part once the expectation that the part will be made is acquired. This first subtlety is known as the frame problem in plan formation and the second involves the use of general constraints defining allowable situations. What is needed are general mechanisms and laws for propagating facts from one situation to another as actions are performed. This would involve both forward planning systems to predict new epistemic states as actions are performed and also allow for concurrent sequences of actions to be found which satisfy specific goals, expectations, and beliefs. It would also involve planning systems for dealing with histories of events, where certain facts are known and one is being asked to reconstruct a plausible explanation of what happened. It is expected that these systems should involve generic solutions to these problems rather that the hand coding of each situation/action/fact as is done in most current systems which use lists which are coded separately for each action. A general theory should be given for specifying the propagation of arbitrary sentences of first order quantificational logic supplemented with a wide variety of epistemic, modal, and intentional concepts involving defaults. Phase I goal is to model and simulate a viable solution. Phase II goal is the development of a prototype system in a manufacturing environment.

AF89-138. TITLE: Determination of Mechanical Properties of Materials Subjected to Severe Environments

OBJECTIVE: Determine fracture, fatigue, creep and constructive characteristics of newly developed advanced materials.

DESCRIPTION: Advanced methods including innovative test techniques and unique apparatus, are needed to determine fracture, fatigue, creep and constitutive characteristics of newly developed materials for high performance turbine engines and advanced structures for aeronautical and space applications. Emphasis will be placed on the testing of small samples to determine characteristics such as failure modes, crack growth, damage accumulation, creep, stress rupture, stiffness, and damping, as functions of temperature frequency and other environments under tensile, compressive, and shear loads, both monotonic and cyclic. Typical material systems include: (a) high temperature titanium alloys; (b) titanium aluminides, and nickel aluminides; (c) ceramic matrix composites; and (d) metal matrix composites. Phase I activity will include demonstration of feasibility through assessment of correlating parameters on selected materials. This will lead to Phase II activities of final development of techniques and apparatus including valida-

tion of data base for use for further material development and transition to advanced structural design.

AF89-139. TITLE: Space Power Technology

OBJECTIVE: To develop survivable, lightweight power technology for space applications at the 5-100 kilowatt level.

DESCRIPTION: Development of one or more of the following technologies is needed in the area of space power, including thermal management, power conditioning, energy conversion, and energy storage: (a) fault-tolerant, lightweight power distribution; (b) high frequency (greater than 400 hertz) power distribution; (c) high voltage (100-1000 volts) direct current distribution; (d) insulations and dielectrics; (e) high efficiency (greater than 30%) hardened, solar photovoltaic energy conversion; (f) high temperature (600 degrees C) photovoltaics; (g) autonomous power system operation; (h) high energy density (greater than 50 watt hours per pound) electrochemical energy storage; (i) thermal energy storage; (j) low area lightweight, survivable 100 degrees centigrade radiators; (k) high efficiency heat transport (heat pipes); (l) high efficiency solar thermal concentrating technology; (m) heat receivers and (n) heat to electrical conversion technologies. Phase I goals include study results, analytical derivations and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF89-140. TITLE: Missile Electrical, Thermal, and Mechanical Power (Nonpropulsion)

OBJECTIVE: To develop advanced sources of onboard and ground support power for missiles.

DESCRIPTION: Innovative nonpropulsion, power technology advances are sought that offer revolutionary reductions of life cycle cost, weight and/or volume, and/or increases of active and/or inactive operational lifetimes. The power technologies of interest are hydraulics, actuators, auxiliary power units, ram air turbines, airborne generators and/or electric power systems, thermal control, batteries, and fuel cells. The application areas of interest are onboard sources of power and/or power generation technology, as well as hydraulics and actuation for tactical, strategic and cruise missiles and ground support power for missile silos and/or transporters. The power source goals/desired characteristics are: (a) strategic and tactical onboard power: peak power 22 kw/kg in a pulsed mode, active lifetimes from 1-60 minutes; shelf life of 25 years without maintenance; 1 second delay or less from initiation to full load; operation over altitude range from sea level to 1500 km; operation over temperature range from -54 degrees C to +74 degrees C without power from an external heat source; gravimetric energy density from 25 wh/kg for one-minute lifetimes to over 220 wh/kg for 60-minute lifetimes; volumetric energy densities from 0.1 wh/cc for one-minute lifetimes to over 1 wh/cc for 60-minute lifetimes; size average power range from .1 to 10 kw; (b) silo power source: 15 years' inactive lifetime; active lifetimes up to 10,000 hours; 900 wh/kg or greater; 1.5 wh/cc or greater thermal efficiency of 90%; 500 kg or greater modules; (c) silo energy storage: 15 years' lifetime; round-trip energy efficiency 80%; 220 wh/kg; 1 kw/kg peak power capability; 1000 discharges/charges; 0.6 wh/cc; minimum self discharge rate of 10,000 hours; size 50 kwh or larger; and (d) cruise missiles: dynamic power sources

up to 5,000 watt with energy densities approaching 0.6 kw/kg and lifetimes of 10s of hours; electrical actuator systems in the integral horsepower arena. Phase I goals include study results, analytical derivations and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF89-141. TITLE: Pulsed Power for Airborne/Spaceborne Applications

OBJECTIVE: To develop pulsed power component technology for airborne/spaceborne applications.

DESCRIPTION: Development of one or more of the following advanced pulsed power component technologies is needed for future airborne/spaceborne high power applications: (a) advanced lightweight power sources with power densities less than .02 kilograms/kilowatt; (b) capacitive energy storage devices with energy densities approaching or exceeding 3 kilojoules/kilogram, output voltage of greater than 10 kilovolts, response time of less than 10 nanoseconds, and lifetimes of greater than 10 million pulses per device; (c) inductive energy storage devices with energy densities approaching or exceeding 100 kilojoules/kilograms; (d) repetitive opening switches capable of hundreds to thousands of cycles when interrupting 2-4 megamperes at several hundred volts; (e) closing switches for repetitive switching of average currents of 10-100 amperes at voltages of 100-500 kilovolts; (f) advanced lightweight pulse forming networks for peak power pulses at tens to hundreds of gigawatts with rise times of tenths of nanoseconds, pulse widths of 10-1000 nanoseconds and repetition rates of 10 hertz to 10 kilohertz; (g) high current density pulse conductors that are lightweight with high tensile strength and are suitable for airborne and spaceborne operating environments; (h) advanced lightweight, high voltage, high temperature, radiation tolerant insulations suitable for airborne or spaceborne operating environments; (i) high temperature, high dielectric strength, low dissipation factor, radiation tolerant power semiconductor devices with a maximum junction temperature exceeding 500 degrees Kelvin and the ability to switch tens/hundreds/thousands of amperes at 5-20 kilovolts per device; (j) high permeability, ultralow loss ferromagnetic materials for application in passive and active magnetic systems; (k) development of control algorithms and philosophies for the autonomous or quasi-autonomous operation of high power systems in conjunction with their power sources for a variety of pulsed loads such as microwave sources and lasers; (l) RF power generator; (m) high power density sources including batteries, fuel cells, turbogenerators, and thermionic energy conversion systems; and (n) superconductivity as applied to pulsed power componentry. Phase I goals include study results, analytical derivations and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF89-142. TITLE: Power Technology for High-Performance Aircraft

OBJECTIVE: To develop electrical, mechanical, fluid, and energy storage system and component power technologies.

DESCRIPTION: Development of one or more of the following advanced power technologies is required for future aircraft: (a) high temperature (greater than 500 centigrade) components, fluids, and seals for hydraulic systems; (b) energy-efficient hydraulic technology; (c) cold weather (-55 centigrade) energy storage technology (batteries, hydraulic accumulators, capacitors); (d)

fault-tolerant power technology; (e) solid-state power controllers; (f) high temperature (200-1000 centigrade) wire, cable, connectors, power semiconductors, and filter capacitors; (g) high temperature (300 centigrade, 30 million Gauss-Oersted permanent magnets (h) innovative converter/inverter capabilities for producing high quality three-phase 400 hertz power; (i) lightweight shafts, gearing clutches, housings, and gearboxes with special emphasis on advanced materials; (j) high performance small turbine technology; (k) electromagnetic actuator and other electrically-driven systems such as fuel pumps; (l) cooling techniques for power componentry and hot aircraft surfaces; and (m) 20 kilohertz power generation and distribution technology. Phase I goals include study results, analytical derivations and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF89-143. TITLE: Thermionic Energy Conversion Technology

OBJECTIVE: Develop key technologies for compact, survivable thermionic nuclear power supplies in the 5-25 kW range.

DESCRIPTION: The Air Force requires nuclear power supplies for evolutionary power needs in the range of 5-25 kW for space use in the late 1990's The perceived advantages of nuclear power in this range are that it facilitates use of electric propulsion for attitude control; reduces payload moment of inertia, reduces radar cross section, facilitates use of power hungry electronic devices which would otherwise not be used, etc. Lifetime requirements are in the range of seven to ten years. Examples of key technology items include long-lived thermionic electrodes, innovative candidate electrical insulators, innovative converter geometries and configurations, innovative plasma operating modes for converters, compact accident-proof reactor core designs, and so on. Phase I activities will normally include experimental demonstration of basic feasibility for specific components, with extended life testing occurring as part of Phase II.

AF89-144. TITLE: Combined Cycle Propulsion Technology

OBJECTIVE: To develop combined cycle propulsion system concepts which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations.

DESCRIPTION: New and novel concepts and approaches are sought for combined cycle propulsion systems which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations. Combined cycle propulsion systems are designed to operate over a wide range of flight Mach numbers from 0 to 8 or above. Current emphasis is on turboramjets operating over flight Mach numbers of 0 to 6. Both manned and unmanned vehicles are involved. The aim of combined cycle propulsion systems is to maximize the overall system efficiency by exploiting the attributes of the various elements in their respective best operating speed regimes. In addition to maximum efficiency, emphasis is also placed on low weight, volume, and cost. Phase I goals are to identify concepts and to conduct preliminary performance assessments. Phase II goals include detailed propulsion flight vehicle integration.

AF89-145. TITLE: Flight Test Instrumentation

OBJECTIVE: To develop concepts and approaches for instrumenting engines installed in hypersonic vehicles to measure engine component performance and durability.

DESCRIPTION: Advanced engines for high speed vehicles such as the National Aero-Space Plane (NASP) will not be tested on the ground above approximately Mach 8. Therefore, engine operation, performance, and durability must be verified during flight tests. Techniques are needed to instrument the engine in non-obtrusive ways, if possible, to document performance, operability, and structural integrity. Measurements desired include pressures, gas and wall temperatures, gas species, and wall strains and deflections. The extreme hypersonic thermal environment offers the main obstacle to overcome. The lack of available space on the hypersonic vehicle mandates the design and development of miniaturized flight equipment and systems. Phase I goals are to identify instrumentation concepts and to conduct feasibility studies. Phase II goals are to establish detailed designs of an instrumentation system and perform experiments of critical elements.

AF89-146. TITLE: Micro-computer Based Earth-to-Orbit Trajectory Optimization Program

OBJECTIVE: To develop an optimizing Earth-to-Orbit vehicle trajectory code capable of being used on a micro-computer.

DESCRIPTION: A method is needed to perform optimized Earth-to-Orbit trajectory (3 degree of freedom) simulations using preliminary design data, including aero and propulsion performance curves. This is to be used on an AT class micro-computer. Emphasis will be placed on time-step results and final conditions. Phase I is to include development and demonstration of algorithm. Phase II will include prototyping of computer code and associated documentation.

AF89-147. TITLE: Micro-Sample Analysis of Aviation Turbine Fuels

OBJECTIVE: Develop methods to determine a wide variety of fuel properties from a small sample amount.

DESCRIPTION: Fuel specifications require measuring a substantial number of physical and chemical properties for each batch of fuel produced. Some of these methods are quick and simple, while others involve a detailed test procedure and substantial amount of fuel sample. There have been tremendous gains in recent years to replace some of the older test methods with modern analytical techniques such as simulated distillation by gas chromatography. Several newer methods are in various stages of development, and may become standard practice in the near future. Recently a group in Australia has been able to determine nine fuel properties based on results of high performance liquid chromatography (HPLC) and either gas chromatography or carbon-13 nuclear magnetic resonance (NMR) procedures. Others have used near-infrared spectroscopy to determine key properties of gasoline. Of great interest is the further development of such techniques which may be used to determine as many as possible of the physical and chemical properties of fuels such as JP-4, JP-5, JP-7, JP-8, and newer hydrocarbon fuels produced from various sources. Investigation of test methods, instrumentation, and chemometric relationships which will calculate properties based on one or two tests conducted on an extremely small amount of sample will constitute the Phase I

program. The Phase I product will be the proposed method/instrumentation to be further pursued in detail in Phase II, along with preliminary results which led to the proposed method. The Phase II product will be a detailed instrumental procedure and chemometric data reduction package which will produce fuel property values with an acceptable level of correlation with measured values.

AF89-148. TITLE: Fuel Combustion Technology

OBJECTIVE: To demonstrate advances in the combustion of fuels for aviation turbine engines.

DESCRIPTION: Improved performance of subsonic, supersonic, and hypersonic flight vehicles will require advances in fuel combustion technology. Specific topics of interest include: Fuel-air mixing techniques for increased combustion efficiency, reduced pressure losses, and smaller and lighter combustors. Fuel atomization and droplet dispersion techniques to increase control over the fuel vaporization and the local fuel-air ratio. Unique techniques to predict and extend the lean blow-off limits of combustors and to improve their low temperature starting and high altitude relight performance when using high viscosity, low volatility fuels. Advanced non-intrusive diagnostics to make simultaneous, multiple point measurements of temperature, pressure, species types and concentrations, and other parameters of interest in turbulent, reacting flows. A Phase I program in this technology should result in a concept demonstration. This could take the form of a small scale experiment or a sound numerical analysis that demonstrates the potential for successfully enhancing the combustion process or the measurement of such a process. A successful Phase II effort would demonstrate the concept at full scale, illustrating the utility of the concept for applications of interest to the Air Force.

AF89-149. TITLE: Determination of Thermal Stability Characteristics of High Mach Fuels

OBJECTIVE: Determine the thermal stability/degradation of hydrocarbon fuels when subjected to high heat loads.

DESCRIPTION: The thermal stability of hydrocarbon fuels is influenced by temperature, time, pressure, and the materials in contact with the fuel. Advanced test methods and techniques are needed to measure and predict the formation of deposits within fuel system components resulting from the degradation of fuels in the liquid, vapor, and supercritical states. Of particular interest is the development of predictive mathematical codes that accurately integrate the combined effects of fluid flow, thermodynamics, heat exchange, and fuel degradation reactions within aircraft and engine fuel systems. The successful development of this code will tie together the results of small scale thermal stability test devices and part scale and full scale fuel system simulators. The proposed mathematical code will be useful in the design of future aircraft and engine fuel systems. The Phase I goal is to successfully demonstrate a fluid flow/heat exchange/fuel deposition model. A simple one-step chemical reaction equation for deposit formation may be used to define where fuel deposits are generated and deposited. The Phase II goal is the development of a complete mathematical code that includes all important fluid flow effects, heat exchange, multi-step chemical reaction equations, and accurate models of the quantity of fuel degradation products that deposit on surfaces. The mathematical code is to accurately identify the locations

within complex heat exchangers and fuel system components where fuel deposits will collect.

AF89-150. TITLE: Solid Lubricants and Their Distribution for Advanced Aircraft Gas Turbines

OBJECTIVE: To design a solid lubricant system (including on-board storage, distribution, control, and reclamation) suitable for installation in a fighter aircraft.

DESCRIPTION: Future aircraft turbine engines will gain much of their performance from higher cycle temperatures. Current liquids, used to lubricate bearings and other components, will not be able to survive the cycle imposed temperatures. Protection of the liquid lubricant will incur severe aircraft performance penalties. One potential solution to this temperature problem is to use a solid lubricant (e.g., powdered MoS_2) to minimize bearing friction and wear. That solution requires a distribution and control system to be incorporated into the engine and/or aircraft. Phase I of this effort shall result in the definition of system concepts for lubrication of turbine engine components with low coefficient of friction solid materials. The materials and system concepts shall be capable of supporting fighter aircraft installed, turbine engine needs over its full operating envelope. For each engine system, only a single lubricant material and form is to be considered. The system shall provide for on-board aircraft storage, distribution, control, and (if appropriate) reclamation/scavenge for recirculation. Materials/concepts posing a hazard to the aircraft, environment and/or personnel are not acceptable. Phase II of this effort shall result in the completion of a preliminary design of a selected material and system. The design shall fully satisfy the requirements of a gas turbine engine, installed in an advanced fighter. The preliminary design shall be sufficiently defined to enable ready transition to Phase III, concept demonstration. Phase II shall also include limited experimental development of key hardware concepts to reduce risks associated with Phase III system development.

AF89-151. TITLE: Development of Improved High Temperature Solid Lubrication Concepts

OBJECTIVE: Investigate high temperature solid lubricants and lubrication concepts for gas turbine engines which would be capable of operating from temperatures of -65 deg F up to 1500 deg F.

DESCRIPTION: Advanced limited life small turbine engines will require large increases in thrust to weight ratio and specific fuel consumption. To achieve this goal and meet high engine operating temperatures, solid lubrication concepts must be further developed. In addition, the lubricants must be capable of withstanding temperature transitions from low to high and environmental effects. Phase I activity will include the study of surface chemical effects of high temperature lubricants and an investigation of their tribological performance. This will lead to Phase II activities of development and fabrication of the most promising concepts.

AF89-152. TITLE: High Temperature Magnetic Bearing Development

OBJECTIVE: To develop high temperature magnetic bearing technology for man rated high performance turbine engines.

DESCRIPTION: Studies conducted under the Integrated High Performance Turbine Engine Technologies (IHPTET) Initiative show turbine engine performance can be improved by increasing engine operating temperatures. To meet IHPTET goals, advancements in high temperature bearing technology will be required. Magnetic bearings may have potential for long life support of the engine mainshaft in IHPTET applications.

Phase I of this program will establish the necessary criteria to design a high temperature magnetic bearing. The end product of the Phase I effort will be a high temperature magnetic bearing design capable of supporting both axial and radial loads. Two areas that should be addressed in performing the Phase I program are: physical properties of magnetic materials at temperatures up to 1000 deg F; and a trade-off study between weight, envelope dimensions, and input power for a 650 deg F and a 1000 deg F operational bearing.

Phase II of this program would be to fabricate the Phase I design and test at turbine engine operating conditions. If successful, this technology would have Phase III potential in high temperature turbine engines as well as other high technology applications.

AF89-153. TITLE: High Temperature Gas Turbine Lubrication System Wear Monitoring

OBJECTIVE: Develop new techniques for the analysis of wear debris in the lubrication systems of high temperature engines.

DESCRIPTION: The subject of operating gas turbines at very high temperatures is one of increasing interest as the Armed Services look forward to propulsion systems for the year 2000 and beyond. The successful development of high temperature engines will depend on use of techniques which will permit a study of the wear mechanisms occurring in the bearings, gears and other rotating lubrication system components. Ferrography and various spectrographic techniques are now widely used for the analysis of wear in current engines, but new concepts or processes will be required to extend the capabilities of these techniques to paramagnetic and diamagnetic materials so that wear debris may be studied in ceramic engines. Consideration also needs to be directed toward the development of new in-line concepts for monitoring lubrication system wear at lubricant temperatures up to 400 deg C. Phase I activity will include concept and design studies for advanced condition monitoring techniques while Phase II will include final design, construction of prototype instrumentation and demonstration of techniques.

AF89-154. TITLE: Solid Lubricants for Advanced Turbine Engine Powder Delivery Systems

OBJECTIVE: Identify, formulate and/or develop solid lubricants that are stable over -60 deg F to 1500 F range for extended use in advanced turbines utilizing recirculating powder delivery systems.

DESCRIPTION: Well known solid lubricants such as molybdenum disulfide and graphite are laminar solids that function successfully by carrying high normal

loads while permitting shearing under only small tangential forces. However, such materials have lower than desired temperature limits due to oxidation. Solid lubricants or compacts serviceable near 1500 deg F typically function by softening over a narrow temperature range. The softening causes deformation and agglomeration that alters and degrades the solid lubricant for use on following cycles through the system. Thus, powder delivery systems typically have suffered from non-uniform delivery of the lubricant. The approach selected is to identify, formulate and/or develop a solid lubricant that would be chemically and physically stable in such usage and generate a low coefficient friction over the -60 deg F to 1500 deg F full temperature range for periods up to 3000 hours of engine operation. Phase I activity will include concept, identification, formulation and/or development of suitable solid lubricants, while Phase II will include demonstration of the utility of using the selected lubricants in a model or simulated system.

AF89-155. TITLE: Augmentor Acoustic Instability

OBJECTIVE: To identify the physical causes of acoustic instability and methods of suppression and avoidance for high performance aircraft gas turbine engine augmentors.

DESCRIPTION: In-depth analysis and review of openly available literature shall be used to identify the causal physics of combustion driven acoustic resonances in gas turbine augmentor environments. Instabilities studied will focus on the 800 to 1200 Hertz range. Analysis shall include the review of both theoretical and empirical data bases. From the analytical studies, methods of suppression and avoidance of resonances shall be identified. Proposed methods to eliminate resonances shall be consistent with the practical features and environmental limitations of gas turbine augmentors. A test plan shall be prepared identifying the testing and development work required to validate the physics and suppression/avoidance concepts identified. The test plan developed must be consistent with the time and funding constraints of an SBIR Phase II program. Under Phase II, the information gained under Phase I will be used to design and fabricate a subscale test article which exhibits acoustic resonances in the 800 to 1200 Hertz range. Testing shall demonstrate both the resonant states of the test article and the effectiveness of Phase I proposed suppression and avoidance methods.

AF89-156. TITLE: Turbine Engine Test Instrumentation Techniques

OBJECTIVE: To develop new sensors/systems for the accurate determination of the strains and temperatures under which engine structural components must operate during engine test cell demonstrations.

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test cell evaluation programs are limited by the problems associated with current structural instrumentation capabilities. The state of the art of structural instrumentation has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine demonstration tests are particularly impaired by the fact that present instrumentation is commonly temperature limited, shortlived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor. For these reasons, new sensors/systems capable of surviving the harsh environments of advanced

turbine engine tests while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding the temperatures and strains typical of turbine engine tests for extended periods while detecting strain to within plus or minus 5 percent and temperature to within plus or minus 1 percent. Additionally, proposed techniques should have minimal influence on blade parameters and gas flow path. The goal of any Phase I effort shall be a basic feasibility demonstration of the advanced sensing concept. Phase II goals shall include a full scale demonstration of the technique in an environment which duplicates the anticipated conditions in the turbine engine.

AF89-157. TITLE: Compression System Design Methodology

OBJECTIVE: To develop and advance the aerodynamic/mechanical state of the art of compression systems including internal flows.

DESCRIPTION: A major trend in compression system hardware is the increased utilization of low aspect ratio blading, blisks, swept blading and three-dimensional design methodology. The primary and secondary flow system design capability must be extended fully into three dimensions to adequately exploit these trends. Therefore, there is interest in any new and innovative ideas addressing the above. Areas of prime importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation, trenching, labyrinth and brush seals, and disc pumping), time unsteady features of the turbomachinery gas path, and secondary flow systems. Additionally, such phenomenological areas as water ingestion, ice ingestion, steam ingestion, dust ingestion, and full face overpressure area of interest. Models accurately describing the effects of external influences, such as these, are of interest.

Phase I goals will encompass conceptual ideas, computer code upgrades and preliminary design modifications. Phase II goals will encompass execution of bench tests and other verification techniques for the ideas identified as high potential in Phase I.

AF89-158. TITLE: Reliability Prediction Models for Military Avionics

OBJECTIVE: To develop a reliability model for avionics which utilizes environmental, storage, shipping, and other components necessary for a complete reliability analysis.

DESCRIPTION: Equipment which supports the operations of military interests must have the capability to consistently perform its intended tasks under various extreme conditions. The ability to accurately predict the probability of successful equipment operation (reliability) before its actual use in the field would enhance the Air Force's decision making strategy. Reliability models exist in the commercial electronics sector which could be modified to a military application. Phase I activity will include identifying possible prediction models and investigating their potential military use. The targeted models should provide greater reliability insight than current military reliability models. Phase II activities will be to expand the targeted model and perform reliability testing to verify the model.

AF89-159. TITLE: Automatic Test Equipment (ATE) Requirements Specification Authoring Tool

OBJECTIVE: To reduce Air Force manpower requirements and improve the quality and consistency of ATE contractual specifications.

DESCRIPTION: Many diagnostics applications using expert system technology are being developed; however, the tools to support the development of contractual documents for specification of automatic test equipment (ATE) requirements is not available. To reduce Air Force manpower requirements and improve the quality and consistency of ATE contractual specifications, it is necessary to develop an expert system to aid in developing an ATE request for proposal. The Phase I effort will develop a prorotype expert authoring system that will demonstrate the feasibility of developing ATE specifications. The expert authoring system should operate on personal computers that are readily available throughout the Air Force, such as IBM PC compatible computers. The authoring system shall reduce the technical manpower requirements by at least a factor of 100 to 1. It must also provide a low cost means to distribute the authoring capability to multiple locations. The Phase II effort will expand the prototype expert authoring system to implement the remaining revised acquisition guides as well as implementing improvements to the user interface.

AF89-160. TITLE: Modular Automatic Test Equipment (MATE) Guide Expert Presentation System

OBJECTIVE: To facilitate the rapid retrieval of information as required by the individual users to meet their acquisition planning or design requirements.

DESCRIPTION: Due to the complexity of planning, developing and acquiring built-in-test, design for testability, and off-line test equipment the Air Force developed a set of acquisition guides. The guides are currently undergoing a major update. One of the goals of the update is to make the thousands of pages of data easier to use. Artificial Intelligence and new computer technology holds the promise of making the retrieval of data easier. This Phase I effort should develop a proof of principle demonstration expert presentation system to provide access to the revised acquisition guides. The system should respond to english language queries. Access to information should be possible without extensive knowledge of the guides or the acquisition process. The system should respond to a single query with all relevant information contained in the guides. Presentation of guide information should match the cognitive model of the task at hand. It should permit the rapid retrieval of information as required by the individual users to meet their acquisition planning or design requirements. The Phase I proof of principle Expert Presentation System shall also be used to demonstrate the feasibility of using the system to support an acquisition program office and to rapidly respond to telephone queries from various program offices that request information from MATE Program Office personnel. The expert presentation system should operate on personal computers of engineering workstations that are readily available throughout the Air Force. During the Phase II effort the proof of principle model will be expanded to enhance the man-machine interface and to provide access to all portions of the revised acquisition guides.

AF89-161. TITLE: Fiber Optic Delay Line

OBJECTIVE: To develop methods to reduce the cose of coherent memory/delay devices for countermeasures systems.

DESCRIPTION: Current Digital RF Memories (DRFM's) are limited by high cost, high power consumption, narrow bandwidths, generally poor spectral performance, and low reliability. Developments in multi-bit devices improve spectral performance but at the penalty of even higher cost and power. Recent advances in fiber optic technology, especially in dynamic range and bandwidth, make it a candidate for use as a coherent memory device. While DRFM's have unique capabilities, their flexibility often tempts the system designer to use them for many functions which can also be accomplished by conventional devices, sometimes as a penalty to overall performance. This program shall concentrate mainly on DRFM capabilities for coherent RF storage for variable durations. During Phase I, the contractor shall evaluate which DRFM functions can be achieved by a fiber optic device and propose one or more hardware configurations. During Phase II, hardware shall be built and tested to evaluate these configurations.

AF89-162. TITLE: New Concepts and Innovations for Aeronautical Systems/ Subsystems

OBJECTIVE: To develop new concepts and innovations for aeronautical systems/ subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical systems/subsystems research, development, and acquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (ie, tactical, airlift, mobility, strategic, transatmospherics, etc). Emphasis is placed on potential long term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, innovative R&D organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF89-163. TITLE: Artificial Intelligence Applied to Aeronautical Systems

OBJECTIVE: To develop Artificial Intelligence applied to all aspects of the Air Force Mission.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of artificial intelligence. It is meant to provide the innovator with latitude to include areas of application not addressed by other specific aeronautical topics. This general area covers all aspects of artificial intelligence (ie, knowledge representation, innovative architectures, expert systems, etc). This subject area is to be considered as applying to all aspects of the Air Force Mission. Therefore, it applies to office procedures, logistics, and maintenance, and as innovative applications of the science of artificial intelligence in solving Air Force problems.

AF89-164. TITLE: New Concepts and Innovations for Logistics Support

OBJECTIVE: To develop new concepts and innovations for logistic support research, acquisition, and management.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of logistics support research, acquisition, and management. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific topics. This general area covers the full spectrum of Air Force logistics (ie, design interface, maintenance planning, supply support, technical data, etc). Emphasis is placed on potential long term planning concepts such as, logistics and maintenance support of unmanned vehicles. Topics as diverse as new technology impacts on traditional logistics planning and logistics techniques for mobile tactical Air Forces can be submitted. Some other areas of interest are impacts of new operational concepts and logistics organizations, models to assess the effectiveness of logistics planning in wartime situations, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF89-165. TITLE: New Concepts and Innovations to Enhance the Cost Estimation of Aeronautical Systems/Subsystems

OBJECTIVE: To develop or upgrade cost estimating tools to evaluate the Life Cycle Cost effects of new concepts and innovations during the conceptual phase of development.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of cost estimating from the laboratory to the fielding of weapon systems/subsystems. It is also intended to provide latitude to the innovator to cover specific technologies as well as the accumulation of these initiatives into a total systems/subsystems cost model. Lack of an ability to evaluate the cost of technologies being considered across the PROJECT FORECAST arena will severely impact out year budgetary planning resulting in project cancellation due to the infamous "cost growth." High Temperature Materials; Ultra-Light Airframes; Smart Skins; High Performance Turbine Engines; Combined Cycle Engines; STOVL/VTOL Technology; Advance Manufacturing Technology; every imaginable new system (Hypersonic, supersonic VTOL, special operations, etc.) are all beyond today's cost estimating capability and should be addressed individually and in combination. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF89-166. TITLE: New Concepts and Innovations for Special Operations Aircraft Systems/Subsystems

OBJECTIVE: To develop and assess the operational utility of new concepts and innovations related to Special Operations.

DESCRIPTION: Special operations forces are interested in new concepts and innovations related to future air transport of special operations forces elements. This effort is intended to develop and assess new concepts in the area of special operations aircraft, and it is intended to cover all facets of special operations aircraft research, development, and acquisition. The innovator has latitude to include trade-offs at the subsystem and major component area. Emphasis is placed on weapon system concepts and improved operational techniques/concepts. Areas of interest are propulsion, avionics, flight control, insertion/extraction devices, and other subsystem concepts. Innovative ideas for the logistics, supportability, reliability and maintain-

ability areas are important considerations. Work will require access to, storage and creation of classified data, and personnel with security clearances.

AF89-167. TITLE: Primary Aircraft Trainer System (PATS)

OBJECTIVES: Identification of alternatives and trade-offs for the PATS to include criteria justification and training media selection.

DESCRIPTION: The justification for this effort comes from a validated need for an Air Force primary flight training system. PATS is envisioned to replace the aging T-37B fleet within the future Specialized Undergraduate Pilot Training (SUPT) System. It is concerned with teaching and developing primary flight skills through a multi-media program which might include computer based instruction, ground training devices, and a primary aircraft trainer. Possible alternatives include further modifications to the T-37B, off-the-shelf acquisition of a new existing primary trainer and associated training system, and a new development primary trainer and system.

Phase I will deliver a listing of specific alternatives meeting the need and methods of evaluating or comparing them. Included will be possible criteria which are relevant, such as life cycle cost or training effectiveness. Alternatives will include specification of all required elements of the PATS.

Phase II will evaluate the alternatives in terms of the criteria identified in Phase I and will conclude with the specification of the best alternative. Specification will include relation of training objectives to training medium, phasing of training in a general sense, and possible innovative mixing of media to enhance overall training effectiveness. The purpose is to allow creativity; hence, the ground rules for this effort will not be limited in scope.

AF89-168. TITLE: Mission Opportunities for Airship Technology (MOAT)

OBJECTIVE: To examine various aspects of Lighter-Than-Air (LTA) systems to support Air Force missions.

DESCRIPTIONS: This effort will be used to assist the Air Force in understanding and determining the capability of LTA systems to meet Air Force needs. Tasks could involve one or more of the following: (1) Review and analyze USAF requirements that could be fulfilled by LTA systems, (2) Define specific LTA missions and concepts of operation, (3) Assess technology opportunities for LTA systems, (4) Investigate potential LTA developmental and operational risk areas such as survivability, ground operations, human factors, and design factors, (5) Determine cost/benefits of LTA systems, and (6) Develop computer models to simulate or analyze any of the above areas. Other appropriate tasks may be submitted for consideration. The effort should be oriented toward the 1994-2014 time period. All types of LTA concepts and missions may be considered - including free and tethered balloons, traditional airships, hybird airships, manned or unmanned systems, and low, medium, or high altitude missions. All USAF mission areas may be considered.

Phase I may be structured in any manner which considers the above tasks commensurate with the submitter's background. The Phase I product will be a

report that describes the selected areas of research, methodology, conclusions, recommendations, and proposed Phase II follow-on efforts. Phase II should consist of an in-depth investigation of LTA capabilities and may include computer analysis and modeling, test programs, etc.

AF89-169. TITLE: Determination of Panel Flutter Characteristics of Kevlar-Polyester Composite Panels

OBJECTIVE: Determine vibration, damping, and failure characteristics of Kevlar-Polyester composite panels under airloads of locally subsonic, transonic, and supersonic airflow.

DESCRIPTION: Some work has been done in determining the vibration, damping, and failure characteristics of metal panels. In contrast, no published references were found for composite panels during the extensive literature search. A thorough investigation of the vibration, damping, and failure characteristics of flat and curved composite panels is required, particularly panels made of the Kevlar-Polyester composite. This composite is being used in large radomes and antenna fairings used by satellite communications terminal equipped aircraft. The Phase I research should include a survey of possible analysis techniques and a final recommended technique to predict flutter in composite panels and/or shells. Phase II activities will consist of developing a computer program to predict panel flutter and its characteristics. Validation of the algorithm with a wind tunnel test at transonic and supersonic Mach numbers should also be included.

AF89-170. TITLE: 3-D Numerical Windflow Model

OBJECTIVE: Develop a mesoscale 3-D numerical windflow model suitable for predicting windflow patterns in the complex terrain of Vandenberg Air Force Base.

DESCRIPTION: A computer model is needed for predicting windflow patterns at Vandenberg Air Force Base. Vandenberg Air Force Base is located on the central California coast in terrain consisting of flatlands, valleys, canyons, ridgelines, and mountains rising to elevations of over 2,000 feet. Windflow is influenced by synoptic, regional and local meteorologic factors and interaction with the terrain. A strong inversion often affects windflow in the area.

This complex natural environment necessitates use of a 3-D numerical model for predicting dispersion of clouds originating at ground and elevated levels. The model will be used in combination with existing diffusion models. The area of interest is approximately 15 miles by 15 miles in size. Model horizontal and vertical resolution should be adequate to represent important windflow intricacies. Meteorologic and terrain data will be provided.

The desired Phase I product is a preliminary computer code suitable for evaluation. The desired Phase II product is a completed and validated computer code capable of providing specific windflow information.

AF89-171. TITLE: Personal Hydrazine Vapor Dosimeter

OBJECTIVE: To develop a toxic vapor dosimeter for monitoring worker exposure to hydrazine rocket propellants.

DESCRIPTION: Hydrazines are widely used as rocket propulsion fuels in space launch operations. Because they are extremely toxic compounds, categorized as suspected human carcinogens, the propellant handlers must be protected from exposures to hazardous levels. The threshold limit values (TLVs) of the three amine fuels, N_2H_4 (Hydrazine), MMH (Monomethylhydrazine), and UDMH (Unsymmetrical Dimethylhydrazine), are 0.1, 0.2, and 0.5 ppm (parts per million), respectively. A reliable yet inexpensive device capable of detecting hypergol vapor below the TLV level is required toward propellant handlers of the presence of hydrazine at sufficiently low concentrations to alert them of impending danger.

The dosimeter, which may be passive or an active device, shall possess sufficient sensitivity to indicate a response upon ten minutes or less exposure at 50% of the TLV. The response shall be readily observable in real time such as an obvious change in color without having to wait for analysis results obtained in a laboratory at a later time. An incorporation of an audio alarm system would be highly desirable. It shall be lightweight and compact (shirt pocket size) and exhibit interface free behavior that will not yield false positive response in the presence of other contaminant gases. The propellant vapor reactive component of the device shall be inexpensive and readily replaceable if not long lasting and possess a six month storage capability without exhibiting performance degradation.

Phase I of this effort shall be a concept feasibility design and building of a breadboard prototype of the device to be developed under Phase II. Although several approaches and propellant vapor reactive systems may be initially investigated, one will be selected based on demonstrated potential for further development into a viable device having field applications. The selection will be supported by experimental data substantiating the sensitivity, reproducibility, selectivity, and quick response features inherent in the system. At the conclusion of Phase I, the contractor shall conduct performance tests to show that all requirements of the personal propellant vapor dosimeter have essentially been assigned. If any of these features fall short of requirements, the contractor must show how and why the specific shortcoming could be alleviated if not eliminated.

During Phase II, the dosimeter device developed in Phase I will be developed, modified and adjusted to improve the performance of the device. No major research effort shall be conducted in this phase but rather the work shall emphasize improving the prototype device and designing the various individual components into a compact total device. Sufficient quantity of prototype dosimeters shall be fabricated and a field evaluation carried out at an operational facility. The field test results will be reviewed for additional minor modifications to be incorporated into the final design of a personal propellant vapor dosimeter.

AF89-172. TITLE: <u>System to Measure Cloud Meteorological Parameters</u>

OBJECTIVE: Develop a prototype (working lab model) of an optimum system to measure clouds meteorological parameters.

DESCRIPTION: This effort should concentrate on the MJCS (Memorandum from the Joint Chiefs of Staff) 154-86, Meteorological Requirements for Defense

Environmental Satellites, 1 Aug 86, Clouds section (available through the Defense Technical Information Center). In particular, clouds, precipitation, and liquid/solid water content and cloud droplet size distribution parameters should be addressed. One or more MJCS 154-86 parameter may be investigated in the proposed effort.

Phase I should address the conceptual design of an optimum clouds data collection system. The system should satisfy the clouds (imagery, coverage, type, layers), precipitation, and/or liquid/solid water content and cloud droplet size distribution requirements of MJCS 154-86, Military Requirements for Defense Environmental Satellites. The Phase I design should consider satisfying as many of the clouds parameters as possible in a single, cost effective system. Pros and cons of systems should be addressed.

Phase II shall include furthering the Phase I concept into development of a prototype (working lab model) of the optimum system to measure clouds meteorological parameters.

AF89-173. TITLE: System to Measure Atmospherics Meteorological Parameters

OBJECTIVE: Develop a prototype (working lab model) of an optimum system to measure atmospherics meteorological parameters.

DESCRIPTION: This effort should concentrate on the MJCS (Memorandum from the Joint Chiefs of Staff) 154-86, Meteorological Requirements for Defense Environmental Satellites, 1 Aug 86, Atmospherics section (available through the Defense Technical Information Center). In particular, vertical temperature profile, absolute humidity (moisture profile), wind (horizontal and vertical components), visibility, pressure profile, and Albedo parameters should be addressed. One or more MJCS 154-86 parameter may be investigated in the proposed effort.

Phase I should address the conceptual design of an optimum atmospherics data collection system. The system should satisfy the vertical temperature profile, absolute humidity (moisture profile), wind (horizontal and vertical components), visibility, pressure profile, and/or Albedo requirements of MJCS 154-86, Military Requirements for Defense Environmental Satellites. The Phase I design should consider satisfying as many of the atmospherics parameters as possible in a single, cost effective system. For example, possible areas of investigation for wind include, but are not limited to, lidar and millimeter wave candidate systems. Pros and cons of systems should be addressed.

Phase II shall include furthering the Phase I concept into development of a prototype (working lab model) of the optimum system to measure atmospherics meteorological parameters.

AF89-174. TITLE: System to Measure Terrestrial or Solar Geophysical Meteorological Parameters

OBJECTIVE: Develop a prototype (working lab model) of an optimum system to measure terrestrial or solar geophysical meteorological parameters.

DESCRIPTION: This effort should concentrate on the MJCS (Memorandum from the Joint Chiefs of Staff) 154-86, Meteorological Requirements for Defense

Environmental Satellites, 1 Aug 86, Terrestrial and Solar Geophysical sections (available through the Defense Technical Information Center, see Reference A). In particular, soil moisture, snow cover, land-locked ice cover, land surface temperature, vegetation, radiation backgrounds, surface pressure, electron density profiles, neutral density, solar spectral imagery/flux, auroral emissions and airglow, solar wind, geomagnetic field, precipitating electrons and ions, in-situ electric fields, cosmic rays (solar and galactic), trapped particles, and ionospheric scintillation parameters should be addressed. One or more MJCS 154-86 parameter may be investigated in the proposed effort.

Phase I should address the conceptual design of an optimum terrestrial or solar geophysical data collection system. The system should satisfy the soil moisture, snow cover, land-locked ice cover, land surface temperature, vegetation, radiation backgrounds, surface pressure, electron density profiles, neutral density, solar spectral imagery/flux, auroral emissions and airglow, solar wind, geomagnetic field, precipitating electrons and ions, in-situ electric fields, cosmic rays (solar and galactic), trapped particles, and/or ionospheric scintillation requirements of MJCS 154-86, Military Requirements for Defense Environmental Satellites. The Phase I design should consider satisfying as many of the terrestrial or solar geophysical parameters as possible in a single, cost effective system. Pros and cons of systems should be addressed.

Phase II shall include furthering the Phase I concept into development of a prototype of the optimum system to measure terrestrial or solar geophysical meteorological parameters.

AF89-175. TITLE: System to Measure Oceanography Meteorological Parameters

OBJECTIVE: Develop a prototype of an optimum system to measure oceanography meteorological parameters.

DESCRIPTION: This effort should concentrate on the MJCS (Memorandum from the Joint Chiefs of Staff) 154-86, Meteorological Requirements for Defense Environmental Satellites, 1 Aug 86, Oceanography section (available through the Defense Technical Information Center, see Reference A). In particular, sea ice, sea surface temperature, sea surface topography, ocean waves (sea, swell, surf), ocean vertical temperature profile, bathymetry (deep ocean and near shore), salinity, near shore currents, ocean currents (surface and subsurface), insolation, ocean tides, heat flux, sediment transport, turbidity, ocean color (photosynthesis pigments), and bioluminescence parameters should be addressed. One or more MJCS 154-86 parameter may be investigated in the proposed effort.

Phase I should address the conceptual design of an optimum oceanography data collection system. The system should satisfy the sea ice, sea surface temperature, sea surface topography, ocean waves (sea, swell, surf), ocean vertical temperature profile, bathymetry (deep ocean and near shore), salinity, near shore currents, ocean currents (surface and subsurface), insolation, ocean tides, heat flux, sediment transport, turbidity, ocean color (photosynthesis pigments), and/or bioluminescence requirements of MJCS 154-86, Military Requirements for Defense Environmental Satellites. The Phase I design should consider satisfying as many of the oceanography parameters as possible in a single, cost effective system. Pros and cons of systems should be addressed.

Phase II shall include furthering the Phase I concept into development of a prototype of the optimum system to measure oceanography meteorological parameters.

AF89-176. TITLE: Innovative Concepts for Improved Space Object Surveillance and Classification

OBJECTIVE: To develop new technologies and innovative applications of existing technologies to improve space object surveillance and classification.

DESCRIPTION: New technologies and innovative applications of existing technologies need to be investigated to improve space object surveillance and classification. Classification should include a determination of the mission and potential hostile intent of space objects. Topics of particular interest include, but are not limited to: optical design for high off-axis rejection of visible light in centered telescopes for space object surveillance; decontamination of optics on space sensors for visible light applications; sun and earth shades on space sensors for visible light applications; nuclear event detection; improved resolution and cloud penetration techniques for ground based systems; and radar and laser techniques for classification of space based systems.

Phase I will define the concepts and establish the technology and methodology requirements to validate the concept. The contractor shall provide a rough estimate of anticipated improvements over the existing systems, as well as projected cost savings. Phase II will develop a laboratory model, validate the technology and demonstrate in the laboratory the concepts proposed in Phase I.

AF89-177. TITLE: Innovative Concepts for Space Systems and Launch Systems Cost Reduction

OBJECTIVE: To develop innovative concepts to help reduce costs associated with access to space and the development and production of space systems.

DESCRIPTION: The Air Force is looking for innovative concepts to reduce costs of launch operations, launch vehicle production, space system manufacturing and space operations. Space systems include both on-orbit satellites and associated ground stations and user terminals. Phase I will define the concepts and establish the technology and methodology requirements to validate each concept.

AF89-178. TITLE: Innovative Space Systems Survivability Concepts

OBJECTIVE: To develop new approaches for ensuring the survivability of DoD space systems to support U.S. and allied combat forces.

DESCRIPTION: Air Force space systems enhance the war fighting capability of strategic and tactical forces by providing communications, navigation, meteorological, and other support functions. As U.S. military forces become more and more dependent on satellite support there is increasing interest in investigating innovative approaches for achieving satellite survivability. These include, but are not limited to satellite maneuvering, tethered decoys, mirror shields, radiation-hard electronic components, and assorted materials for

laser protection. The ultimate outcome of this effort will be the implementation of an innovative survivability concept into a DoD space system. Phase I will define the approach and describe the feasibility of developing the survivability enhancement concept.

AF89-179. TITLE: Innovative Concepts for Force Support from Space

OBJECTIVE: To identify new and/or improved methods of supporting military forces from space.

DESCRIPTION: Space systems provide critical support for operational military forces, including navigation, communications, meteorological data, and surveillance data. The Air Force seeks innovative improvements in these capabilities for providing support to all military operations. This support may include current or new types. Current types of support may be accomplished with new approaches or technology. New types of support should be described in sufficient depth to permit evaluation. New technology, for example in computer and data links, can improve our capabilities. To better support terrestrial forces, innovative, small, inexpensive, user friendly equipment is required. Phase I will define the concept and describe the feasibility of developing force support from space. Phase II will develop a laboratory model, validate the technology and demonstrate in the laboratory the concepts proposed in Phase I.

AF89-180. TITLE: Techniques to Perform Military Space Capability Modeling and Cost Estimation Modeling

OBJECTIVE: To develop space systems modeling techniques for deployment trade offs or develops space system cost estimation modeling techniques.

DESCRIPTION: There exists a need to: 1) model satellite architectures and constellation descriptions in order to minimize deployment costs, and 2) estimate space system costs by requirement in order to analyze system requirements versus the costs before the design phase. The information should be easily interpreted by the user. The space capability model should show the effects on the mission if satellites in the constellation become inoperative. Input parameters should include coverage, size of satellite, position, weight, number of vehicles, type of technology used, and mission requirements. The cost estimating techniques should address the costs associated with each mission requirement. The model should be able to relate mission requirements through visual means, such as flow and block diagrams. These models must run on an IBM Personal Computer (PC) or micro-VAX compatible systems. The model must identify input parameters prior to running and be capable of accepting changes to input parameters prior to execution. This allows for a continual updating of the program with new technologies or ideas. Accompanying this model must be the documentation and listing of the program. Offerors may respond to either the cost estimation modeling or the space capability modeling tasks or both. Phase I will describe the feasibility of developing satellite architecture models. Phase II will develop, demonstrate and validate the concepts of Phase I.

AF89-181. TITLE: Innovative Applications of Emerging and Mature Technologies for Air Force Space Capabilities

OBJECTIVE: To identify innovative applications of emerging and mature technologies for military space missions.

DESCRIPTION: Innovative applications of emerging and mature technologies and bold new concepts for the 21st century and in basic physical and engineering sciences are needed for military space missions. Relevant 21st century areas include, but are not limited to; physics, chemistry, energy conversion, propulsion, space power, and signatures. New technology areas of particular interest include low thrust electric propulsion high power density (greater than 10 kilowatts/cc) solid core, gas cooled fission propulsion reactors; and non-propulsive space transportation. Phase I will define the concept and establish the technology and methodology requirements to validate and demonstrate the Phase I proposal. Phase II will develop, validate and demonstrate the Phase I proposal. Proof-of-concept feasibility is the product of Phase II.

AF89-182. TITLE: Concepts for Improved Satellite Communications Support to Theater Commanders

OBJECTIVE: Identify and evaluate new approaches for deploying satellites which will provide theater commanders with dedicated communications support.

DESCRIPTION: The current military satellite communications architecture is based on a time-sharing system using a few large, multi-band, multi-channel satellites which may not be available to quickly relay urgent messages from a theater commander to a deployed unit, or vice versa. However, in a crisis, theater commanders must have guaranteed access to communications channels to effectively monitor and control the immediate situation. Hence, approaches to provide alternatives or improvements to the current architecture are needed. Proposers are requested to identify one or more satellite communication support improvements and propose an approach. Phase I will define the approach and describe the feasibility of improving satellite communication support to theater commanders. Phase II will develop a laboratory model, validate the technology and demonstrate in the laboratory the concepts proposed in Phase I.

AF89-183. TITLE: Global Positioning System (GPS) Translator Data Recording and Relay

OBJECTIVE: Develop innovative techniques to interface GPS translator data with conventional telemetry receive/record sites; and relay the data using conventional microwave channels.

DESCRIPTION: Test vehicles are being equipped with GPS translators that relay GPS satellite signals and a pilot carrier on S-band (2200-2400 MHz). The signals are then received, recorded and processed at range telemetry sites. Currently, extensive hardware additions must be made at each telemetry site to provide real time recording and processing. Large cost savings would be realized if hardware could be developed to interface the translator signals to telemetry analog recorders; and to relay the data to a central processor via microwave.

In Phase I of the effort, one or more system concepts shall be developed, and systems level descriptions of recorder and microwave relay interface hardware

shall be developed. Cost effective alternatives shall be addressed. A particular requirement is to relay the GPS translator data on a microwave channel that has a 7.5 MHz sub-carrier, a 3 MHz bandwidth, and 3 degree phase jitter at the receiver. Another requirement is to reduce interface hardware cost and size to a small fraction of the current processing equipment that is presently being purchased by the Government (8-12 racks).

In Phase II, one of the approaches defined in Phase I will be chosen by the Government and developed by the contractor into prototype units. The prototypes will be demonstrated by the contractor at a Government test range facility and performance verified by the Government.

AF89-184. TITLE: Optical Measurement of Small Angular Displacements in a Dynamic Environment

OBJECTIVE: Develop techniques enabling very accurate angular measurements from a mobile platform. Successive measurements must be rapidly repeatable.

DESCRIPTION: Future space-borne on-orbit testing of weapon systems will require scoring and miss distance measurements. In cases where on board vehicle instrumentation is not feasible an off board measurement approach from an airborne or space borne platform appears applicable. Potential methodologies should include but not be limited to gated video systems and laser radar techniques. A key element in the determination of position between two vehicles approaching each other at a high velocity is the measurement of sub-microradian angular displacements in a dynamic (mobile) environment to less than 0.3 arc sec accuracy. The type of instrumentation to be tested in the dynamic environment are optical sensors which include optical encoders equal to or greater than 22 bits (less than or equal to 0.305 sec/bit or 0.0015 microradians/bit). These measurements not only need to be highly accurate but also need to be very frequent (greater than or equal to ten times per sec).

Phase I will develop the design and test methodology to measure angular displacements on a dynamic airborne platform. Considerations should be given to environmental factors such as aircraft vibration and thermal contraction and expansion.

Phase II should include the development of instrumentation for testing on an airborne platform. A KC-135 or similar type aircraft would be an appropriate consideration. In lieu of aircraft availability for testing, a laboratory simulation should be developed.

AF89-185. TITLE: Millimeter Wave Electronic Beam Scan Technology

OBJECTIVE: Develop a new millimeter wave beam scan technology for phased array applications.

DESCRIPTION: Satellite-to-satellite communications in a fixed geosynchronized orbit can take advantage of line-of-sight narrow beams for high data rate secure communications. With the increase in space activities, multi-link or internetted satellite communications may be required through the use of narrow beam scanning technology. Millimeter wave beam scanning offers the advantage of narrow beam communications in space with small antennas. Current millimeter wave electronic beam switches are based on phased array concepts with millimeter wave phase shifters using either ferrite devices or semiconductor

devices. Ferrite phase shifters are bulky and lossy, about 6 deciBels (dB) per 360 degree phase shift at 60 GHz. Gallium Arsenide (GaAs) phase shifters also have high losses, i.e. 10 dB per 360 degree phase shift. Another major limitation for the 60 GHz phased array is its heat dissipation capability due to a large number of elements required for a very small area. Typically, a four inch array at 60 GHz will have 3600 elements. This not only creates a severe heat dissipation problem, but also makes it extremely difficult to implement a large number of active devices in each element.

Innovative concepts are solicited to develop a 60 GHz electronic beam scan technique to minimize the aforementioned problems. In Phase I the contractor shall conduct phased array design and design analysis. In Phase II the contractor shall construct a 2 x 2 subarray and demonstrate 90 degree two dimensional electronic beam steering at 60 GHz.

AF89-186. TITLE: Implementing Expert Systems Onboard Satellite Systems

OBJECTIVE: Address problems with using expert systems onboard satellites. Problems center around DOD-STD-1750A processors, mission recovery, fault tolerance, and reliability.

DESCRIPTION: New and future satellites may benefit from the use of onboard expert systems to increase survivability and autonomy. Problems associated with using expert systems onboard satellite systems are of interest. Specifically:

1. Implementing expert systems on DOD-STD-1659A processors. How can expert systems be effectively hosted on the 1750A architecture? What approaches would be used to implement an expert systems code efficiently on a 1750A computer system?

2. Using expert systems to aid in satellite mission recovery. Ideas are solicited for the recovery/reestablishment of a disabled or damaged satellite's mission(s). Identification of failed or damaged subsystems, selection of work-arounds, data and software reloads, satellite location and recontact procedures are example of challenges to be considered.

3. Strategies for satellite knowledge base fault tolerance. As increasing use is made of onboard expert systems, the problem of validating and verifying the knowledge bases becomes acute. Latent errors in the knowledge bases can lead to unprecedented complex system behaviors. As strategies for tolerating such latent errors are proposed, a methodical approach for evaluating those strategies is required.

4. Reliability of satellite onboard expert systems. Many years of experience with the effects and causes of errors on traditional software and data bases have resulted in strategies for both assessing and projecting their reliability. Strategies for assessing or projecting the reliability of onboard expert systems are not as accessible. Bold new and innovative strategies and approaches for evaluating and projecting the reliability of satellite onboard expert systems are solicited.

SBIR contractors are asked to address only one of the above areas in detail. Phase I will develop the proof-of-concept and analyses of the proposed approach. Phase II will formalize and document the approach and apply the approach to at least one test case. The use of actual data from operational

satellites will be used if possible for the test case(s). Particular attention will be given to revolutionary approaches based on state-of-the-art technology and implementation techniques.

AF89-187. TITLE: Novel Concepts for Survivable Space Power and Supporting Technologies

OBJECTIVE: Develop lightweight space power and thermal management components which provide enhanced survivability against the natural space environment and hostile threats.

DESCRIPTION: As the required electrical power level increase to the 10 to 1000 KWe range for Air Force space missions, the power system takes up an increasingly larger portion of the spacecraft mass. One of the primary technical issues for future space power systems will be to achieve significant reductions in system mass. Power systems also need to be hardened against anticipated hostile threats while still providing reliable long life operation. The Air Force is interested in developing lightweight survivable space power and thermal management components. Areas of particular interest are: 1) solar photovoltaic arrays, 2) large solar concentrators, 3) dynamic power cycles, 4) high efficiency thermal storage systems, 5) lightweight direct contact heat exchangers, 6) advanced radiators, and 7) thermal management fluid control.

For solar photovoltaic arrays, the primary technical issue is to minimize or eliminate power losses due to environmental interactions and hostile threats. Innovative uses of materials, geometries, and other survivability enhancing techniques should be used. Design parameters: array power of 10 to 100 KWe with array specific power greater than 25 W/kg. For large solar concentrators advanced concepts that are easily deployable and able to stay on orbit for years with minimal losses of concentration efficiency is the technical challenge. Design parameters: equivalent solar dynamic power of 100 to 1000 KWe with concentrator mass of less than 2 kg/m^2. For dynamic power cycles, identifying innovative alternatives to the conventional power cycles (Sterling, Brayton, and Rankine) is the technical challenge. Power cycles and working fluids should be specifically optimized for operation in the space environment. Design parameters: power of 10 to 100 KWe with cycle specific power of greater than 25 W/kg. The primary technical challenges for the practical application of thermal storage concepts are: high equivalent specific heat capacity, temperature matching, effective thermal conduction into and out of the thermal storage material, and long term stability in the space environment. For lightweight direct contact heat exchangers, a key technical issue is high separation efficiency of the heat exchange media in a microgravity environment while minimizing heat exchanger mass. Applications of these heat exchangers to the Brayton and Rankine power cycles are of the greatest interest. For advanced radiators concepts, specific masses should be less than 1.0 kg/kw at a 300 deg K radiating temperature, and/or 0.2 kg/KW in the 500 deg K temperature range while maximizing survivability. In any active thermal management subsystem, there exists the requirement for fluid flow management at minimum weight, long service life, and high reliability.

An offeror may submit more than one proposal in response to this topic, but each proposal should cover only one area of interest. For each effort, Phase I should produce a complete analysis of the concept's feasibility, a prediction of performance characteristics, and a design of a proof of principle model. Technical issues such as high efficiency, lightweight, long

life, and high reliability are of prime interest. In Phase II, small scale models will be fabricated and tested under simulated operational conditions.

AF89-188. TITLE: Self Deploying Space Structures

OBJECTIVE: The objective of this project is to determine the feasibility of fabricating a roll up self deploying laminate antenna reflector for space applications.

DESCRIPTION: Technology needs to be developed to enable the Air Force (AF) to have simplified deployment of specialized structural components in a space environment. Composite materials can be fabricated so that they are pliable and can be folded or rolled into low weight, small packages. This project will demonstrate that an antenna reflector can be fabricated in such a way that, when rolled up, it will deploy into its original constructed shape without the use of actuators. Thus a network of antenna reflectors or other similar structures could be launched into space and deployed for communications or energy focusing. Various laminate constructions will be studied and fabricated to determine the proper laminate orientation for memory retention. In Phase I, the contractor will perform design analysis to determine the optimum laminate designs, and will then fabricate subscale panels. Material systems to be explored for this program should include graphite epoxy and thermal plastic materials, along with other promising material systems. The contractor will determine how to best measure various constructions and materials for rollability, compaction and memory retention. In Phase II using the data obtained in Phase I from the subscale components, larger panels simulating space antenna reflectors will be fabricated from the most promising designs, and materials. The contractor will also measure the rollability, compaction and memory retention of these structures using the techniques developed in Phase I. One of the most promising Phase II structures should be demonstrated in a simulated space environment.

AF89-189. TITLE: Development of Acceptance Criteria in Carbon-Carbon Materials for Space Structures

OBJECTIVE: The objective of this task is to develop material models with capabilities of treating non-uniformities present in Carbon-Carbon materials with respect thermomechanical properties and strength of carbon-carbon materials.

DESCRIPTION: Carbon-carbon (C-C) materials, due to the nature of their fabrication and processing, frequently contain flaws. These flaws typically consist of broken fibers, bowed or misaligned fibers, matrix cracks, and other inhomogeneities such as extremely porous regions resulting from poor impregnation and carbonization. To date, there is little understanding of the effects of these flaws on the thermomechanical properties and strengths of C-C materials. The development of imperfection acceptance criteria for C-C materials is of prime importance to the successful utilization of these materials in space structures. The expense of C-C materials precludes a comprehensive test program from being performed to develop the acceptance criteria. Consequently, a successful acceptance criteria development program must utilize mathematical material models which will allow the effects of imperfection to be determined. In Phase I of this program the contractor will develop material models with the capabilities of treating non-uniformities in composite materials. The contractor will look at the C-C material structure and determine the types of

anomalies to model. Material models will be developed which will allow evaluation of the effects of various types and sizes of imperfections upon the thermal and mechanical properties and strengths of C-C composite structural elements. In the Phase II program the application of these models to generate quantitative information to allow the development of acceptance criteria should be addressed. The contractor should look at verifying his analytical models through fabrication, inspection and mechanical testing if necessary. A first cut imperfection criteria for C-C composites for space structure applications is a Phase II deliverable item.

AF89-190. TITLE: Dynamic Computed Tomography

OBJECTIVE: The objective of this program is to demonstrate the feasibility of obtaining computed tomography (CT) data of a solid propulsion system while it is being fired.

DESCRIPTION: There is currently no method of obtaining CT data on a motor or nozzle assembly while it is being statically test fired. The designers and users of a propulsion system depend upon analytical models to describe motor burning characteristics and to describe the charring and erosion of ablative insulators and liners. A dynamic CT system would provide actual experimental data in place of postulated model data. If dynamic CT ability is achieved, the solid propulsion designers, scientists and engineers will have a tool that can provide information about localized grain burn rates around the motor within slot and fin cavities, and the capability to study anomalous burning and charring in a solid rocket motor. Overall this tool would yield a better understanding of motor performance. The advantage of "real time" CT over real-time-radiography (RTR) is that the data is quantitative in nature. Position of the events are recorded in three dimensions. The basic theory of CT and experience inspecting rocket motors and nozzle components indicates that CT should provide the desired data. In Phase I the contractor will determine the feasibility of obtaining dynamic CT and the contractor will design the dynamic CT system in Phase I for use in the Phase II demonstration. The contractor will work with the AF project manager to determine what AF facilities are available to be used in a Phase II feasibility demonstration. Phase II will consist of feasibility demonstrations of the dynamic CT concept, data reduction and reporting. The results from this project will be used to provide direction on future technology programs to achieve a realtime CT capability integrated into a motor test stand.

AF89-191. TITLE: Hydrogen Storage in Metal Hydrides

OBJECTIVE: To develop a rechargeable hydrogen storage system employing metal hydrides as the storage medium.

DESCRIPTION: Hydrogen has long been recognized as an attractive energy source. Its high energy output per unit mass makes hydrogen not only a desirable alternative energy source in an internal combustion engine to power motor vehicles, but an ideal fuel for space applications and rocket propulsion where a high energy density is particularly important. Such a use relates to Project Forecast II's High Energy Density Matter effort. One of the problems with hydrogen's wide spread use as an energy source is the difficulty associated with storage. Container weight and safety considerations are problems with gas storage and large amounts of energy are consumed in the liquefaction process if the hydrogen is stored as the liquid. The use of

metal hydrides may provide a safe and effective storage medium. The hydride formation is reversible, produces a stable product, and a unit volume of the metal hydride can hold more hydrogen than gaseous or liquid hydrogen. A metal hydrogen storage system would be appealing for space applications in two ways. First, a stable method of hydrogen storage would eliminate problems associated with cryogenic storage, such as tank leakage and required weight/volume ratio of tanks. Secondly, the metal hydride storage system itself could be used as an energetic fuel for propulsion or power generation. The research to be performed is in this area of hydrogen storage using metal hydrides. Innovations need to be developed to improve the kinetics of hydrogen uptake/release, determine how to prepare the metal for maximum hydrogen loading, and examine which metals or alloys are most suitable for the stated application (e.g. have energy densities by weight and volume that surpass the current iron-titanium hydride). Success will be measured by comparison to existing space storage systems. Phase I would examine the potential for such storage schemes and would include the evaluation of several different metals as a storage medium. Phase II work would involve experiments using selected metals in developing storage and release methods. The work would lead to a storage system that could be employed as an energy source.

AF89-192. TITLE: Technology for Storage, Handling, or Use of Antimatter

OBJECTIVE: Develop technology in the area of: 1) analysis of matter-antimatter annihilation radiation; 2) prediction of its products and effects; or 3) safe long-term, high density storage systems for antimatter.

DESCRIPTION: Antimatter is composed of quantum mechanical particles which have reverse properties of their normal matter counterparts. When antimatter and matter are allowed to interact, the entire mass of both is converted into energetic radiation, mostly charged pion and gamma rays in the near field. The property of antimatter has led to concepts for the use of stored antimatter as an analytic radiation source in the near term, and as an energy source for rocket propellant in the far term. Proposals are sought to design and demonstrate an element of the technology needed to use antimatter which: 1) can be developed within the funding and time limitations of an SBIR procurement, and 2) can be demonstrated using an appropriate form of normal matter (a normal matter analog) to simulate antimatter. For instance, solid hydrogen could be used as a normal matter analog of solid antihydrogen in a magnetic suspension system. Examples of the technologies sought include: wide angle, high resolution X-ray fluorescence, annihilation gamma ray, or charged pion detector arrays to locate and characterize annihilation sites within normal matter; storage systems for charged or neutral solid antihydrogen; computer models and software for predicting annihilation products and their effects; and other innovative technologies. The first phase of this effort shall consist of a design for the proposed technology element. In Phase II, the selected item shall be built and demonstrated with a normal matter analog. Designs shall consider (as applicable): radiological safety with respect to annihilation rates; vacuum requirements; temperature requirements (solid antihydrogen storage will probably require a 1 deg Kelvin radiative heat sink); proposed uses of the technology; and other appropriate constraints.

AF89-193. TITLE: Separation and Purification of Propellant Polymers

OBJECTIVE: To develop innovative separation and purification technique for propellant polymers with the use of gases that are super critical solvents at laboratory pressures and temperatures.

DESCRIPTION: Solid rocket motors are composed of a powdered fuel and granular oxidizer which are held together by a polymer called a binder. There are numerous examples in the solid rocket propulsion community where rocket motor failures can be traced to the presence of very low molecular weight contaminants. Traces of monomer and dimers that form in the initial production of the binders are thought to be the cause of some of the problems. Most binders are cured with an isocyanate curative, hence, water can interfere with the cure reaction and can also cause the cast rocket motor to fail. Super critical fluid extraction has been shown by M. McHugh and V. Krukonis to be a valuable technique of extracting low molecular monomers and dimers from certain polymer systems. This liquid can then be used to extract different components depending upon the pressure of the system. The high molecular weight polymer is virtually insoluble in this compressed heated gas while the low molecular weight material is easily removed when the gas is vented to another container.

Phase 1: Super Critical Extraction Parameters. Develop innovative methods of containing viscous propellant polymers in a high pressure extraction cell. Determine the solubility parameters for various propellant polymers in super critical fluids. Measure the relative purification and molecular weight fractionization of propellant polymers.

Phase 2: Design of Extraction System for Propellant Ingredients. The solubility data from Phase 1 will be used to design an extractor that can be used for binders and other propellant ingredients.

AF89-194. TITLE: <u>High-Sensitivity Short and Medium Wave Infrared Cameras</u>

OBJECTIVE: Design of ground and space based short and medium wave infrared cameras of high sensitivity.

DESCRIPTION: Short wave infrared (SWIR)/medium wave infrared (MWIR) measurements are needed to characterize (1) emissions produced in space by shuttle surfaces, particulates, other spacecraft contaminants, and engine plumes, and (2) the spatial variability of atmospheric infrared emissions. The expected military consequences of these emissions include degradation of optical and infrared surveillance sensors by local background emissions and failure to discriminate targets against a structured infrared atmospheric background, as well as the betrayal of space assets to hostile forces. New cameras for direct imaging and analysis of these infrared signatures can be based on recent technological advances, with platinum silicide or other materials, that have produced infrared detectors characterized by high sensitivity, low noise, and large high-density linear and mosaic arrays. This abstract has two separate tasks, which can be responded to either separately or jointly.

Task A: Space-Qualified Camera for Optical Emissions in Space. Cameras that employ large-array detectors can have high sensitivity because they are staring instruments; that is, the whole image is recorded at once rather than over an interval during which the object is scanned. Prototypes have been very successful, and the advantages of this technology should now be extended for use in space. The objective of this task is to design and build a camera for a series of space experiments aboard the space shuttle and shuttle-borne

spacecraft. It should be adaptable to almost any flight opportunity by designing for compatibility with typical shuttle and spacecraft support platforms. The Phase I product is to be a preliminary design. It will start with existing detector technologies, laboratory model, and flight-feasibility study; include an assessment of the sensitivity required to match the expected brightness of emissions to be studied; progress to selecting and optimizing detector material and type, maintaining the detector cryogenic temperature, handling the large volume of digital images, and assuring space-qualified mechanical and optical designs; and result in meeting the requirements of a typical spacecraft preliminary design review. Phase II will produce the final design and construction of a prototype flight instrument, for which the Air Force Geophysics Laboratory will seek an actual flight opportunity in which it will be used to study spacecraft environmental interactions.

Task B: Ground-Based Camera for Atmospheric Emissions. This task proposes the design of a sensitive high-resolution infrared camera for the direct measurement of atmospheric emissions in observational programs using both ground- and aircraft-based sensors. The camera is to observe auroral and airglow emissions in the wavelength region extending from approximately one to six microns. The Phase I product is to be a feasibility study of different experimental approaches and the presentation of a proposed camera design. Design consideration should be given to providing high sensitivity, high spatial resolution, subsecond temporal resolution with a time-averaging capability for weak emissions, flexibility in the observation of a series of different wavelengths, radiometric precision, and a wide dynamic range. Particular emphasis should be given to approaching the theoretical limits of measurement capability in signal-to-noise ratio and spatial resolving power. The Phase II effort will construct a prototype camera, test and calibrate it against laboratory sources, and perform demonstration measurements of ground-based night-sky airglow emissions.

AF89-195. TITLE: Ultra-Narrow Band, Tunable, Super-Sensitive IR Detector

OBJECTIVE: To develop a prototype ultra-narrow band, tunable, super-sensitive infrared (IR) detection system.

DESCRIPTION: Satellite-based, infrared surveillance and tracking systems must discriminate infrared targets from spatially and temporally structured backgrounds in the upper atmosphere. In many applications, the performance of the surveillance system is limited by the brightness of the target signature relative to the brightness of the background. The signal to background limitation is particularly severe in the nuclear-disturbed atmosphere. With a sufficiently sensitive infrared detector, narrow band techniques can be used to maximize the ratio of the target signature (from a missile plume for example) to that of the bright background. In the past, detector sensitivity has limited the applicability of narrow band techniques. However, the development of the super-sensitive, solid state photomultiplier (SSPM) permits the detection of single infrared photons. In addition, 56x1 and 6x6 arrays of SSPM detectors have been fabricated and tested. The unprecedented level of sensitivity makes possible the development of ultra-narrow band, tunable infrared detection systems which operate in the SWIR-LWIR wavelength range. The objective of this program is to design, fabricate and test an ultra-narrow band, tunable, infrared detection system. In Phase I an ultra-narrow band, tunable, infrared detection system using a single SSPM detector element will be designed. The sensor will be fabricated and tested to verify the projected performance of the sensor in Phase II.

AF89-196. TITLE: Development of Remote Sensing Algorithms for Atmospheric Path Variables from Radiometric Data

OBJECTIVE: Provide innovative framework in which to design/optimize inversion algorithms for arbitrary spectral data, so as to include particulates, scattering, non-local thermodynamic equilibrium (NLTE), etc.

DESCRIPTION: DoD's reliance upon successful operation of existing and proposed Electro-optical (E/O) sensors from surface, air and space platforms requires optimized descriptions of the environmental path. Path parameters that can influence E/O signatures include the conventional variables (temperature, pressure, and molecular constituent profiles) and a host of non-standard but critical elements (multiple scattering, aerosols, clouds, rain, surface properties, and NLTE). This complement of path parameters can potentially provide the largest source of error in predicting the performance and success of E/O systems.

Phase I for SBIR should explore the feasibility of incorporating non-standard atmospheric elements into line-by-line path characterization (inversion) algorithms. Innovative approaches for defining the required physical parameterizations of one or more of these components, evaluating signature levels, accuracies and information content, will be required. Special emphasis should be placed on implications for multi-spectral instrument design to isolate spectral signatures that are slowly varying (ie. spectral dependence of aerosol size distributions, cloud identification, polarization effects, etc.), as well as the more rapidly varying molecular line signatures (absorption cross sections and NLTE).

Phase II would then entail the implementation of these new algorithms for direct inversion of non-standard variables in conjuction with existing state-of-the-art high resolution spectral radiance modeling using the AFGL Fast Atmospheric Signature Code (FASCOD3). FASCOD3 currently models exact forward radiance predictions based on a "complete" picture of the path variables, including the non-standard elements. (In addition, significant advances in inversion algorithm development already allow generic inference of atmospheric content for conventional variables (path characterization) in conjuction with FASCODE.) Coding concepts developed under this SBIR will enable the DoD community to improve design specifications and interpret critical signature definitions. These algorithms should incorporate state-of-the-art interactive analysis and programming schemes.

AF89-197. TITLE: Cloud-Free Conditions Specified from Satellite

OBJECTIVE: Determine the extent to which cloud-free lines-of-sight and paths-of-travel can be specified using radiometric data from satellites.

DESCRIPTION: Interactions between military systems (friend-friend or friend-foe) which must take place through the potentially cloudy portions of the Earth's atmosphere are in many cases significantly impacted by the presence of clouds within the operating line-of-sight or path-of-travel. (Path-of-travel is the track made upon any intervening plane, e.g. a cloud layer, by the unbroken interaction for some time period between two systems moving relative to one another). Attempts have been made to quantify the probability of these cloud-free conditions during such interactions based upon cloud observations made at surface locations or, to a lesser extent, from aircraft. The input to such techniques is invariably a surface-based estimate

of sky-cover. These assessment schemes are suspected of being site-specific and are known to deal poorly with the situation of interaction from orbit to within-atmosphere, or vice versa.

Since the advent of environmental satellites more than 25 years ago, the possibility of quantifying cloud-free conditions from orbit has, to some extent, existed but the technical challenge is still the exploitation of that possibility. The compelling reasons for utilizing satellite data for this purpose are: (1) the close comparative nature of environmental orbital sensors to orbital surveillance systems, (2) the global scope of coverage offered only by satellite platforms, (3) the high refresh-rate afforded by orbital remote sensors, (4) the nearly equal ability for making cloud-free assessments during day or night. The satellite is the only alternative data source in areas where conventional meteorological information is nonexistent or can be denied. At present no technique for assessing cloud-free conditions based solely on satellite data exists.

During Phase I, a detailed specification will be made of what can be determined in regard to cloud-free assessment using present (and planned) satellite measurement systems. Considered must be domestic (both civilian and military) and foreign (e.g. SPOT) satellite imagers. The topics of sensor resolution, cloud/no-cloud discrimination, multi-channel detection and off-nadir data correction must be addressed. In addition, prototype assessments of cloud-free conditions using examples of satellite images containing varying amounts and types of clouds (total number of such images, at least 30) taken from at least 4 different satellite platforms will be accomplished during Phase I. The main thrust of the Phase II effort will be the quantitative intercomparison of satellite cloud-free specifications with similar assessments accomplished from the Earth's surface using digital whole-sky cloud images, simultaneously and conterminously made. (The digital whole-sky cloud images will be provided as Government Furnished Equipment (GFE)). The other major Phase II task will be the development of optimal techniques for specifying (analytically or in probability terms) cloud-free lines-of-sight and paths-of-travel under various cloud conditions using satellite data only.

AF89-198. TITLE: Programmable Signal Processor for Real-Time Doppler Lidar Wind Measurements

OBJECTIVE: Design and build a programmable processor for computing real time estimates of atmospheric winds from Doppler lidar signals.

DESCRIPTION: Air Force applications of Doppler lidar wind sensors range from space-based global wind measurements to airfield wind shear detection. One requirement that many of these proposed operational systems share is the need for real-time data processing. The Doppler shifted backscatter signal contains information about the winds, turbulence, and aerosol content of the scattering volume, but these parameters must be estimated by time consuming spectral analysis. Conventional computer architectures are simply not well suited for performing these computations in real-time for most Doppler lidar applications. Furthermore, wide signal dynamic range, typically up to 80 decibels, presents problems for many off the shelf processors. The purpose of this contractual effort will be to apply new advances in signal processing technology to the design and construction of a high-speed programmable signal processor for a CO_2 Doppler lidar system (outlined below). Such a processor will have application in numerous ground- and space-based Doppler lidar applications. This processor must be programmable to allow for the development of new

data reduction algorithms and must be capable of computing estimates of mean wind speed, turbulence, and backscattered power. These computations must be done in real- time for the following ground-based lidar system:

Laser Transmitter:	Pulsed CO_2 TEA laser
Laser Wavelength:	10.6 microns
Pulse Width:	1 microsecond
Pulse Repetition Frequency:	up to 100 pulses per second
Receiver:	Heterodyne, 40 MHz offset
Maximum Measurement Range:	30 kilometers
Doppler Wind Bandwidth	20 MHz (-50 to +50 meters/sec)

Inputs to the Doppler processor will be the in-phase and quadrature (I and Q) components of the received backscatter signal. These signals will be centered at baseband and have a half bandwidth of 10 MHz. Output of the processor will be digital data passed to a VAX Unibus computer via a parallel direct memory access (DMA) interface.

Phase I should result in a complete processor design, which if viable, will be built and tested under Phase II. Final testing will be performed with the processor connected to the working lidar outlined above. While this processor will be used for a specific ground-based application, some attention should be given to how the results of this effort could apply to other lidar applications, such as space-based lidar wind sensing.

AF89-199. TITLE: Tunable Narrowband Optical Filters (TNOFs)

OBJECTIVE: Design and construct narrow bandwidth optical filters.

DESCRIPTION: Two specifications are possible within this topic: TNOFs for solar telescope application or for daylight lidars. This abstract has two separate tasks, which can be responded to either separately or jointly.

Task A: Solar Telescope Application. The forecasting of solar activity and its impact on space weather and DoD systems and operations relies on the observation of solar spectral lines which are used to deduce spatial and temporal distributions of temperature, pressure, velocity and magnetic fields and their relationship to solar activity. By introducing computer controlled operation of a suitable optical filter system, it should be possible to achieve very rapid spectral tuning across not only one but several spectral lines in sequence. If the lines selected are formed at different heights in the solar atmosphere, information concerning the physical properties of the atmosphere across a three-dimensional grid could be obtained. While optical filters yielding high quality two-dimensional images at a single wavelength already exist, the problem of developing techniques for computer-controlled rapid scanning across one or more spectral lines represents a challenge to current technology, the solution to which would be of considerable value to many electro-optical projects and laboratories. Phase I would explore the problem of rapid computer-controlled scanning across a single spectral line and the development of a prototype system. Provided Phase I is successful, Phase II would concern the development of a prototype system capable of scanning across several spectral lines and its replication for installation at a number of ground-based solar observatories.

Task B: Daylight Lidar Application. Air Force Lidars are used to measure neutral density and meteoric atomic species in the middle atmosphere (30-100

km altitudes). However, the strong radiance of the daylight sky contributes to the background noise of the optical signal and typically limits Lidar to a night-only operation. To block out this background radiation a novel filter with a narrow bandwidth is required. Requirements for the optical filter are as follows: a characteristic response time smaller than 100 ns; a bandwidth equal to or less than 0.001 nm; and a quantum efficiency greater than 10%. The filter must be designed and packaged so that it can be coupled to a signal-limited detector (e.g. cooled photomultiplier) with a high combined efficiency. Noise power from the filter has to be negligible or comparable to detector noise. It must operate at one of the wavelengths of interest to Rayleigh Lidar: second harmonic of Nd:YAG or XeF excimer; or resonance Lidar: NaD_2, Ca(II) 393 nm, or Fe(I) 372 nm. In Phase I, filter concept and a careful design of the filter-to-detector coupling will be developed. In Phase II, the offeror will optimize efficiencies, fabricate and test the filter/detector. Testing the prototype with an operating Lidar will be required.

AF89-200. TITLE: Nonlinear Materials Development for 0.8 and 1.315 Microns

OBJECTIVE: Improve nonlinear optical properties of materials that operate at 0.8 and 1.315 microns.

DESCRIPTION: Nonlinear materials that operate at 0.8 and 1.315 microns are needed. The goal of this effort is to improve the nonlinear optical properties of materials that operate at 0.8 and 1.315 microns. These materials will be used for four-wave mixing in laser systems. It is required that the materials have: 1) damage thresholds greater than 1 MW/cm^2, 2) response times less than 1 millisecond, 3) high sensitivity (milliwatts of pump power), 4) high nonlinear gain (two orders of magnitude, better than Kerr-like nonlinear media such as Carbon Disulfide), 5) good optical quality, and 6) have heat transfer ability.

The lasers will be either continuous wave or pulsed. Materials used in pulsed lasers must have reasonable memory. Specific properties of interest are CHI(3), response time, and high efficiency. Both organic and inorganic materials will be considered. The ability to reproduce optical properties in samples is also of interest. Phase I: Provide a conceptual demonstration of potential or give detailed analysis of the selected material. This demonstration or analysis needs to show that the material can meet the required specifications. Phase II: Develop optical quality nonlinear material, test and deliver samples of the material. Determine the effect of varying the processing parameters, material composition, and crystal structure on nonlinear material properties. Employ approved characterization and testing techniques to monitor the progress of the work and ensure that the development program yields a material with the specified properties.

AF89-201. TITLE: Far Field Radiation Patterns in the Presence of Air Breakdown

OBJECTIVE: Develop and experimentally validate an algorithm to model far field radiation patterns in the presence of microwave induced air breakdown.

DESCRIPTION: Background. Air breakdown occurs when ambient free electrons are accelerated by an intense electrical field to energies beyond ionization thresholds resulting in an exponential build-up in electron density. When this happens the build-up can block the transmission of further energy through the

charged region. Air breakdown is the limiting factor in propagating an intense microwave pulse through the atmosphere. Phase I. To enhance our ability to model high power microwave propagation, the contractor shall develop an algorithm to model the far field radiation patterns in the presence of air breakdown. Consideration shall be given to both breakdown at the source and to tail erosion along the path of propagation. Any computer processing associated with this effort shall be performed using the computer facilities of the Air Force Weapons Laboratory. Phase II. In Phase II the contractor shall develop a test plan and experimentally validate the developed algorithm using a laboratory scaled device. Air Force high power microwave sources may be available if the contractor can substantiate that a lab scale experimental setup is not feasible. The algorithm, test plan, and a final report are the deliverable products.

AF89-202. TITLE: Mobile Automated High Power Microwave Diagnostic System

OBJECTIVE: Develop microwave diagnostics system which automatically acquires, stores, and reduces data from mobile, pulsed high power microwave testing.

DESCRIPTION: Testing of military systems for effects induced by high power microwaves (HPM) is carried out at a number of sites nationally, including both open air field test sites and controlled anechoic chamber environments. Accurate characterization of the various free field electromagnetic quantities is a key prerequisite to interpretation of these effects tests. Parameters of interest include radiated power density, frequency spectrum of the radiated envelope, envelope shape, and antenna pattern. Because HPM testing is presently carried out by a wide variety of personnel and organizations in both controlled laboratory environments as well as poorly controlled field environments, there is little standardization in measurement techniques. The problem is especially severe in open air field tests because time and space limitations often prevent a full complement of diagnostics from being utilized.

A need exists for a fully automated compact, self-contained HPM data acquisition system which will operate under the direction of a personal computer to rapidly acquire, reduce, and archive data in a harsh field environment. Because next generation HPM sources will repetitively pulse at multi-Hz rates, novel, innovative diagnostic recording, analysis, and storage techniques will be required to interpret the rapid stream of digital data. Because rapid setup and ease of transportation is a key criterion, the HPM diagnostic sensors themselves should be few in number, physically robust, and adequately broadband to characterize electromagnetic environments from sub-GHz to x-band frequencies.

Phase I work will involve innovative design of a set of broadband, physically robust microwave sensors, definition of novel PC-based data reduction and archival algorithms, and selection of appropriate signal capture instrumentation. Together, the system of broadband sensors, fast signal storage, and PC based archival storage resulting from the Phase I study should allow data capture at a minimum of 2 Hz repetition rates and setup in a field test environment by 2 people in a half day. Phase II work will involve fabrication, testing, and optimization of the HPM sensor concepts, acquisition of the signal storage hardware, and implementation of the hardware and software concepts developed under Phase I.

AF89-203. TITLE: Pulse Compression Techniques for High Power Microwave Applications

OBJECTIVE: Investigate the feasibility of using advanced pulse-compression techniques to increase peak output power of high power microwave sources.

DESCRIPTION: Conventional hot cathode microwave sources, such as the klystron, have demonstrated electrical to RF energy and power efficiencies exceeding 50 percent for multi-microsecond pulse lengths and repetition rates exceeding 100 Hz. If the microwave energy produced from such a source in a period of tens of microseconds can be stored, and then released in a time scale of a microsecond or shorter, then potentially short pulses of gigawatt level microwave power can be produced. To date, such high power levels have only been achieved in relatively low efficiency cold-cathode field emission devices, such as the virtual cathode oscillator.

Advanced concepts related to the creation of high efficiency, high energy storage, gigawatt output power pulse compression cavities are needed. Consideration should be given to novel and innovative solutions to the relevant physics and engineering aspects of the overall source/pulse compression cavity/antenna system. These include optimizing physical shape of the storage cavity, materials selections, and method of switching of the RF energy to the output waveguide. The newly developed class of superconducting materials which operates at liquid nitrogen temperatures offers potentially substantial increases in energy storage time and overall efficiency.

Phase I work should explore the feasibility of using advanced high efficiency pulse compression cavities for the following two potential applications: (1) creating gigawatt output power levels from existing or near term state-of-the-art hot cathode microwave sources, and (2) increasing peak output power from existing cold cathode field emission sources to the multi-gigawatt level. Phase II will involve an actual technology demonstration of the most promising concepts developed under the Phase I work.

AF89-204. TITLE: Phased Array Imaging Telescope

OBJECTIVE: Develop new optical designs for spaceborne optical phased array imaging systems having the resolution of a very large single telescope.

DESCRIPTION: The phased array imaging telescope concept has a number of advantages over traditional single telescope systems for space applications where very large effective apertures are required for high resolution. Primary mirrors may be relatively small, lightweight and easy to fabricate and test. The system may be launched either folded up or in pieces, but with individual subtelescopes fully assembled and aligned. The whole system may then be assembled or unfolded with automatic alignment systems doing the critical adjustments.

The phased array telescope must be designed so that the subtelescope positions with respect to each other are not critical. A servo system then adjusts the smaller beam combining optics to superimpose and phase the multiple images to give the resolution of a single very large telescope. This is a relatively simple problem for narrow field of view telescopes used for astronomy or for laser beam projection, but has never been done for a wide field of view.

The key problem is to superimpose and phase the images from each of the subtelescopes at the focal plane where a video sensor or a piece of photographic film resides. Doing this over the entire field of view simultaneously requires that telescope aberrations such as field curvature and distortion be reduced to levels never before required of an optical system. Heretofore insignificant variations in the magnification of the telescopes or in the thickness of refractive elements can prevent the telescope from working properly. Alignment requirements among the subtelescopes can also become prohibitively tight.

The Air Force is interested in phased array telescope designs with the potential to be built with effective aperture sizes of ten meters or larger with a 30 arcminute or greater fields of view. The telescopes must give essentially diffraction limited performance from visible through mid-infrared wavelengths. In Phase I of this project, the contractor should develop a conceptual optical design for a phased array imaging system. At the end of Phase II, the contractor should have an optical design for a laboratory scale demonstration project. Practical considerations such as the ease of fabrication, testing and alignment of the optics and the requirements for the servo control system (if any) should be completed in this phase.

AF89-205. TITLE: Development of Computational Methods for Chemically Reacting Mixing Problems

OBJECTIVE: To develop robust computational methods to deal with various single and two-phase chemically reacting flows and mixing processes.

DESCRIPTION: The Air Force is interested in examining the various parameters that effect single and two-phase chemically reacting flows such as in spray reactors, subsonic and supersonic mixing nozzles and combustors, where mixing plays a very important role. Transverse injection of one of the reactants into the primary flows can enhance mixing but may not improve the chemical reaction. Two phase flows often involve a reaction between a gas and either solid particles or liquid droplets. Decreasing the droplet or particle size increases the effective surface area for reactions to occur, but the increased number of particles and closer distribution can have a dramatic effect on the surrounding neighbors and the gas concentration. Also, smaller drops may get depleted, which may or may not be desirable depending on design consideration. When injected transverse to the primary flow, smaller particles or droplets will have less momentum than larger particles or droplets for a given initial velocity and may get swept along with the free stream before reacting entirely or collecting on an opposite boundary. A design tool is needed to address the various parameters that effect the mixing processes and single and two-phase flows. Tractable methods must be found to model these effects and explore their chemical efficiency.

The end product of Phase I will be an extensive review of existing methods for modeling single and two-phase chemically reacting flows, three-dimensional turbulent mixing, and laminar and turbulent transverse jet and/or particle injections into a free stream. In addition, there will be a demonstration, on a limited scale, of the feasibility of the proposed innovative methods.

The end product of Phase II will be the development of robust methods available for government and industrial use in various applications of combustion and spray reactor design.

AF89-206. TITLE: Video Optical Disk Characterization and Control

OBJECTIVE: Innovative approaches to characterization and control of video optical disks in image analysis system.

DESCRIPTION: Investigations of advanced tracker performance frequently require a programmable access to long time sequences of video imagery. Real-time digitization and storage of large numbers of video frames can be accomplished with specialized, high speed arrays of parallel hard disks. An alternative approach which offers potentially greater payoffs in programmability and cost is the use of analog video optical disks as interim analog signal storage devices. These disks are programmable and can be controlled by micro and mini computer systems with video digitizers to allow sequential digitization of long time series of images at greatly reduced data rates.

Phase I: Innovative approaches to the control of analog video optical disks in support of tracker imagery analysis and database management are sought. Characterization of video disk transfer functions using test video sequences are desired to allow assessment of the loss of fidelity due to the extra analog process in this approach. Studies detailing an approach to control of the video devices from both micro and mini computer systems, and integration with image processing workstations are desired. The Phase II effort would produce a demonstration system.

AF89-207. TITLE: Excited State Populations in a Neutral Particle Beam

OBJECTIVE: To determine the excited state population distribution of the hydrogen atoms in a neutralized energetic hydrogen beam and to implement the information to determine applicability of non-intrusive beam sensing techniques for neutral particle beams.

DESCRIPTION: Neutral particle beam (NPB) direction sensing is a critical concern for systems applications. In order to accurately implement the beam the precise direction of propagation must be known. Demonstrator systems can implement several techniques for beam sensing due to the lower duty factor, current and energy. Laser resonance fluorescence (LRF) and Doppler shift sensing techniques, which are non-intrusive and rely upon the presence of excited state populations in hydrogen to be present, are the current candidates for the higher level systems. There are concerns regarding the predicted low signal to noise ratios for these techniques which could cause the methods to fail. Calculations have been performed to determine the excited state populations expected following a foil neutralizer; however, the assumptions which have to be made for the calculations are significant. The excitation of the neutral hydrogen occurs through the collisional stripping in the foil neutralizer. There is a need to adequately evaluate the beam sensing techniques as applied to actual systems; therefore, a measurement of pertinent excited states should be made to provide a sound technical basis for determining viable beam sensing techniques.

In Phase I, the technique for the absolute measurement of several excited state populations in an existing neutral particle beam system (such as at ANL or BNL) will be designed. The design of the technique should be made as to be germane to the proposed designs for beam sensing, especially in the distance from the neutralizer to the point of measurement. In Phase II, the result from Phase I should be expanded to include demonstration of the technique and

measurements on a range energies of the NPBs in order to determine scaling to an actual weapons grade system. Comparison with theoretical predictions shall then be made. The application of the results to determine the feasibility of the beam sensing techniques for future application to NPBs shall be included.

Af89-208. TITLE: Passive and Active Countermeasures Against Multispectral Target Illumination

OBJECTIVE: Develop and demonstrate passive systems and/or active systems that prevent laser guided munitions from homing in on a target.

DESCRIPTION: Future battlefields will use smart munitions that are guided to their target by detecting reflected light from a laser illuminated spot. These laser illuminators may use different wavelengths and the illuminated spot size will vary as a function of laser design and range to target. Air Force assets as surface to air missile sites, mobile air traffic control facilities, and armored vehicles will be some of the targets that an opponent will want to destroy. To improve the survivability of these assets, it is proposed that innovative ideas be investigated that can passively absorb incident laser light such that there is no reflected light (laser spot is not visible to incoming smart munitions) and/or active systems that passively detect the incident radiation and, through a response action, dispense an aerosol (or other mechanism) that scatters the incident laser beam such that smart munitions can not home in on a reflected laser spot. Some of the challenges to this problem are: (a) any passive material for absorbing incident laser radiation should not enhance the ability for detection in another portion of the electromagnetic spectrum; (b) a system that uses passive sensors to detect incident laser radiation must be able to discriminate laser light from sun light/head lights and be in sufficient numbers to detect any illuminating laser spot (laser spot incident on target); (c) an active system that dispenses an aerosol must take into consideration vehicle velocity, wind direction, that military personnel may be near the mechanism that dispenses the aerosol when this machine is placed in action; and (d) any innovative approach taken must not interfere with the operational function of the asset it is to protect.

Phase I: This effort is to consider the threat to Air Force assets from laser guided munitions and present an effective countermeasure that can increase the survivability of an asset by reducing it's susceptibility to laser illumination from a hostile source. This effort shall result in a final report that gives the government the ability to determine the practicality and usefulness of a proposed solution and the threats that the solution was designed to counter.

Phase II: This effort shall be an actual demonstration of the passive/active system proposed in the Phase I final report. It is anticipated that two (2) two meter square targets, using the proposed passive/active system, shall be delivered with any necessary smoke/aerosol machinery to provide to the government two samples to be tested. Included with these sample targets shall be a final report addressing manufacturing costs of the countermeasure system, recommendations on the best methods to use the system, and limitations on the combat use of this system. This innovative system must at all times emphasize reliability in the combat environment (is it easy to install and maintain) and be cost effective when compared to the given Air Force asset it is to protect (is this system cheap compared to the asset it is on).

AF89-209. TITLE: Ballistic Missile Research

OBJECTIVE: To develop new concepts and innovations for ICBM systems subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of ICBM systems/subsystems research, development, and accquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific ICBM topics. This general area covers the full spectrum of Air Force ICBM missions (i.e., basing, propulsion, guidance and control, defense penetration, target kill, etc.). Emphasis is placed on potential long term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, innovative R&D organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF89-210. TITLE: Generic Qualification of Electronic Piece Part Processes

OBJECTIVE: Develop a standard set of models, software and test procedures to qualify processes instead of individual circuits.

DESCRIPTION: Currently contractors must qualify and maintain qualification on all individual electronic circuits which is an exhaustive task. Qualification testing is required initially and at six month intervals. Generic qualification is the use of Standard Circuits (SC) and Process Control Monitors (PCM) to qualify a process which produces a family of circuits. Specifically, SCs are unique, large, common blocks of circuitry which also contain reliability test structures. SCs are designed to worst case conditions and are used for initial qualification and quality conformance inspection testing of a process. The SCs are designed such that they will represent all circuits from a given process. PCMs are also reliability test structures but are put on every production wafer which goes through the process to monitor and control the process. Using SCs and PCMs will increase cost efficiency and produce a higher reliable part. Phase I will determine the feasibility of developing these tools and address the risk assessment, GFE requirements and manpower requirements. Phase II will develop tools to quantitatively evaluate failure mechanisms and determine worst case conditions for a given process, test procedures, models to construct SCs and PCMs, reliability requirements and reliability evaluation tools. Generic qualification will not replace all the qualification testing required on individual circuits but will still produce a significant cost savings, improved reliability and faster product development time.

AF89-211. TITLE: Propellant Sensitivity to Electrostatic Discharge (ESD)

OBJECTIVE: Examine propellant sensitivity to ESD, and develop a safe casting tool design.

DESCRIPTION: The sensitivity of high performance, aluminum loaded solid propellants to electrostatic discharge is evidenced from the recent catastrophic incidents over the past few years. The electrical charging of motor cases and propellant fin-forming hardware to several tens of kilovolts

poses a serious safety risk. A subsequent potential impulsive electrical discharge could ultimately lead to propellant ignition. The channeling of electrostatic discharge energy into propellant combustion modes involves several steps. The most probable series of channels involve charge build-up, discharge, heat generation, propellant evaporation, ignition and final steady combustion.

It is desired to develop safe casting methods which minimize electrostatic charge build-up on tools which would reduce the risk of accidental propellant ignition through ESD mechanisms. The study program proposed below will seek to mitigate this risk by first developing an understanding of the ESD phenomena and then proposing guidelines for design of safe casting tools.

An examination of ESD propellant sensitivity requires a bottom-up approach. This implies that the most probable mechanistic channels will be identified using best engineering judgement so that a physics model can be developed. Uncertainty in our current knowledge of the controlling physics will probably mean that more then one model will be developed. A series of controlled experiments will be conducted to determine which model or models "best fits' the data.

The physics model for ESD will provide the engineer with an understanding of the key mechanisms underlying the accidental ignition of energetic solid propellants. This will enable the engineer to design a safe propellant casting tool which minimizes the potential for inducing a set of conditions which could ultimately lead to a catastrophic event.

AF89-212. TITLE: Internal Insulation Materials for Future Generation of Solid Rocket Boosters

OBJECTIVE: Develop laboratory procedures for evaluating internal insulation materials for future solid rocket boosters.

DESCRIPTION: Internal insulation in a solid rocket booster is a layer of heat-barrier material placed between the internal surface of the composite booster case and the propellant. The primary function is to prevent the case from reaching temperatures that endanger its structural integrity. The insulation material contains filler or reinforcement embedded in elastomeric binder. When the insulation is exposed to the booster environment consisting of high radiative heat flux, impinging propellant gas and particle and shear flow, the ablation of insulation will occur. As the exposure continues, surface char material will be progressively eroded. Thus, a proper insulation design requires knowledge of the booster environment, the ablative characteristics of the insulation, and furthermore, a demonstrated reliability level desirable in rocket boosters.

The conventional approaches to choose insulation material and size the thickness relied either on the successful experience in previous booster programs or entirely on the full-scale booster firings to generate reliable data. The first approach has the benefits of cost saving but provides little improvement in current plate of the insulation technology. The second approach requires a costly and time-consuming developmental program.

If the application of the state-of-the-art materials technology and cost reduction in insulation development are desired, scale testing (6 inch lite

motor) and the bench-scale testing, such as plasma-arc and oxyacetylene torch test are performed. However, correlations to relate ablation rate from these test data to full-scale booster firing data are often erroneous. The primary drawback of these testings is that they are too crude to simulate the actual booster environment.

In order to meet the objective, the Phase I of the project involves an extensive effort to (1) establish conditions of future booster environment and historical database, (2) identify the state-of-the-art and established insulation materials, (3) evaluate the available performance data, and (4) develop a laboratory procedure which simulates the actual firing environment. Phase II will conduct actual laboratory testing and correlation of the generated laboratory data with available firing data.

AF89-213. TITLE: Effect of Booster Acceleration on Insulation Erosion

OBJECTIVE: Develop standard procedures to characterize the effect of booster acceleration on the erosion rate of various insulation materials for future missiles.

DESCRIPTION: It is a well-known fact in the aerospace industry that internal insulation of a solid rocket motor experiences different erosion rate between flight and static tests. For example, the erosion rate of the forward dome internal insulation of Peacekeeper motors have been known to be much higher for flight tests than that for static tests. The cause for this enhanced erosion phenomenon is the additional mechanical loading, such as shock, vibration, tension and compression acting on the char layer induced by the vehicle acceleration loads. Once the char layer is removed by the acceleration loads, the underlining virgin material is exposed to intense heat flux which then leads to enhanced insulation erosion. To understand insulation performance under vehicle acceleration is important because insulation burn-through can lead to catastrophic flight failure. The need to characterize effect of acceleration on insulation performance is more important for future solid rocket motors, since future motor will subject to high acceleration field (e.g. fastburn booster). Phase I of this effort will develop analytical models to predict insulation performance under various vehicle acceleration levels. Additionally, standard laboratory methods will be developed to thoroughly characterize insulation with respect to physical, mechanical and thermal properties, e.g. surface morphology, decomposition profile, density, and porosity. Phase II will include laboratory experiments to test the models made in Phase I. The final product provide a standard methodology based on which insulator for future high-acceleration rocket motors can be designed.

AF89-214. TITLE: Developing a Storable Injectant for Solid Motor Performance Improvement

OBJECTIVE: Develop a liquid or gaseous injectant which raises performance of solid motors, yet be storable.

DESCRIPTION: The idea of injecting hydrogen into the combustion chamber to raise the performance of solid rocket motors has been proposed several times. The theoretical benefits are substantial; by depressing the molecular weight of the combustion products, the hydrogen (which does not burn or contribute any energy) can theoretically produce increases in specific impulse of ten percent or more. In recent tests at the Air Force Astronautics Laboratory,

hydrogen injection was shown to cause a six percent gain in Isp in a motor firing at sea level. In addition to raising performance, hydrogen injection would allow throttling of the solid motor over a certain range, and impulse management to deliver a very precise total impulse to an airborne vehicle.

Application of this technique to ballistic missiles would have several benefits, such as reduced demand on post boost propulsion systems through more precise control of solid booster burnout velocity, range enhancement through higher delivered specific impulse, lower solid sliver through a slowdown of chamber pressure drop during tailoff, and possible elimination of staging side force problems by using injectant expansion to produce thrust at low levels for the staging event.

The technical challenge is to find a storable injectant, be it hydrogen or something else. Cryogenic liquids are out of the question for typical ballistic missile applications, and the use of high pressure gaseous hydrogen, while it cannot be ruled out, entails significant storage and safety problems. A storable liquid or high-density gas which would evolve a significant amount of hydrogen, yet not absorb so much energy upon dissociation as to lower performance, is desired. Ideally, the material found would be capable of self-pressurizing and self-feeding.

Phase I of this activity should consist of identification of a number of candidate materials, and selection of one or more which promise high performance through thermochemical calculations utilizing NASA SPP or some similar code. A literature search should be conducted to verify the storability of the candidate substances. Phase II will include a series of tests, conducted jointly by the contractor and AFAL, to verify performance improvement and throttleability.

AF89-215. TITLE: Development of Standard Door For ACS Thrusters

OBJECTIVE: Produce a standard ACS door design which will meet ICBM NH&S requirements yet jettison reliably.

DESCRIPTION: The emergence of requirements for hardening ICBMs from nuclear effects brought about a problem for post boost vehicle designers which, while seemingly simple, has consistently proven one of the biggest engineering challenges on PBV programs. That problem is providing protection for attitude control thrusters during the boost phase, and then removing the protection so that the thrusters can fire to maneuver the PBV.

To date, the approach has been to place some sort of protective door over the nozzle exit plane, and rely on the first ACS firing to remove it. Thus, the door's fastening system must be weak enough to fail under the relatively small force provided by the ACS thruster. At the same time, however, the fastening system must be robust enough to keep the door on in the specified nuclear blast environments, not to mention during the dynamic load environments of transportation, basing, nuclear ground shock and boost. The worst of the nuclear effects is pebble impact, where a pebble of a certain size strikes the door at a certain velocity and angle without causing the door to be removed. The design task is therefore on of meeting contradictory requirements, a fact which is never fully appreciated until the first test is conducted. A standard solution to this problem is required, and it may take any form as long as it is applicable to any type of attitude control engine (i.e., monopropellant, solid or bipropellant at any pulsewidth or thrust level). The standard door

design should account for a combination of worst case loads from ICBM programs, such as HML vibration from SICBM, silo flyout acoustics from Minuteman, pebble impact from Peacekeeper or SICBM, etc.; it should then be applicable to virtually any future programs.

Phase I will result in a design or a set of designs along with supporting analysis. Phase II will consist of a development test program which will demonstrate door integrity under adverse conditions, followed by door removal on demand. A single standard design will emerge from Phase II.

AF89-216. TITLE: Thermal Protection Material Characteristics

OBJECTIVE: Develop test techniques to determine the characteristics of thermal protection materials.

DESCRIPTION: The following programs are of interest:

a. Conductivity of Carbon Phenolic: Investigate and measure the surface conductivity of carbon phenolic. Currently, a great deal of uncertainty exists in measurements of this surface conductivity. Factors of 2 to 10 between measurements are not uncommon. This has significant implications for electromagnetic calculations involving antenna windows which are imbedded in heatshields composed of carbon phenolic. The effort should develop accurate measurement techniques for typical carbon phenolic materials at temperatures from room temperature through temperatures associated with reentry environment.

b. Physical Properties of Antenna Window Materials at Elevated Temperature: Investigate and measure the viscosity, specific heat, density, thermal conductivity and other physical properties of reentry vehicle antenna window materials at temperatures above 5000 deg Rankine. The physical properties of these materials are needed to properly determine the performance of the antenna system during reentry. At the very high temperatures associated with reentry many of the antenna window materials such as silica tend to react with crucible materials. This effort should develop a design of test equipment to measure these properties.

AF89-217. TITLE: Cost Reduction in LWIR Radiometry

OBJECTIVE: Develop methods to significantly reduce the cost of long-wave infrared (LWIR) radiometry.

DESCRIPTION: Radiometric measurements of relatively low temperature objects such as ballistic vehicles prior to atmospheric reentry typically entail very expensive hardware. Sensors capable of operating at wavelengths of 20 micrometers and longer are usually desired for such applications. Individual LWIR detector elements with adequate detectivity and radiometric accuracy require exotic materials and demanding fabrication techniques. Mosaics or arrays of such elements therefore tend to be very costly. Whenever the sensor is located within the atmosphere, it must be mounted behind a suitable window or in a windowless cavity. Both options are expensive. The former, because windows with high optical quality and LWIR transmissivity, like detectors, require special materials and techniques. The latter, because a windowless cavity must not introduce excessive distortion due to air turbulence and structural integrity/airworthiness must be maintained. Another cost factor in

LWIR radiometry involves the need to cryogenically cool the focal plane array and possibly the entire optical path in front of it. New materials, fabrication techniques and design approaches are sought which hold promise of significantly reducing the cost of fabricating and/or using LWIR sensors.

AF89-218. TITLE: Aerodynamics and Flowfield Effects

OBJECTIVE: Develop techniques to investigate and measure various Reentry Vehicle (RV) aerodynamic and fluid mechanics phenomena.

DESCRIPTION: The following programs are of interest:

a. Measurement of Chemistry in RV Boundary Layers: Develop methods for making measurements of chemical interactions in shock and boundary layers of sub-scale reentry vehicle models used in a ballistic range. These sub-scale models have thin boundary layers which typically are on the order of 0.1 cm thick. The specific chemical interactions and the location in the boundary layer or shock layer on the model must be identified. The presence and effect of ablation products in the boundary layer on chemical interactions should be included.

b. Measurement of Transition on Ballistic Range Models: Develop new methods to measure the occurrence of transition to turbulent flow on sub-scale conical models used in ballistic ranges. Methods other than Schlieren photography are sought to determine when and where on the model transition occurs. The influence of both thrusted and unthrusted wakes should be considered in the effort.

c. Aerodynamic Coefficients for High Performance Lifting RV: Perform tests obtaining aerodynamic coefficients that are applicable for high performance lifting reentry vehicles. The proposed project would define/develop a class of optimum Maneuvering Reentry Vehicle (MaRV) configurations of fixed geometry for glider and evader missions and to develop classes of variable geometry configurations for highly maneuverable RV's which enhances efficiency of converting kinetic energy to maneuver impulse by providing high (L/D) 3.5 over a wide range of Mach number and angle-of-attack that is possible with any fixed configurations. It is likely that fairly sophisticated CFD techniques will be needed to guide the facility selection and test matrix development.

d. Low Mach Number Aerodynamics: Algorithms are sought to estimate reentry vehicle aerodynamics at high Reynolds number (turbulent) and low Mach number flows ($0.7 < M < 3.5$). Methods for predicting the advent of the transonic angle-of-attack divergence and designs to avoid this dynami instability phenomena are particularly of interest. In addition to engineering correlation, three dimensional inviscid (Euler) flow and Navier-Stokes models may be required. These methodologies should address the maneuvering reentry vehicle yaw stability and base drag. The offeror should be familiar with the state-of-the-art technologies.

e. Hypersonic Three Dimensional Rarefied Flows Analysis: Techniques are sought to estimate the rarefied 3D flow fields around an ascending missile or RV. Emphasis is placed on the calculation of thermal and chemical non-equilibrium phenomena. Development of 3D Monte Carlo Direct Simulation (MCDS) approach is one approach which is ideal for the transitional flow. New concepts and formulations are sought to make MCDS faster and practical in engineering applications. Body configuration of interest is the blunt

multi-conic body and the major parameters of interest are the force/moments, local heat transfer and the detailed flow properties. Flow regimes range from $10-3<Kn<10$ (where Kn equals the Knudsen number). Additionally novel concepts on assessing the validity of Navier-Stokes model with modified boundary conditions (e.g., surface slip, etc.) in rarefied flow environments are sought.

f. Gasjet Nosetip Flow Instability: Methods are sought to identify the mechanisms of producing the flow instability observed on the gasjet nosetip ground testings at AEDC and NSWC tunnels. The objective is to ascertain the causes of these undesirable features and to find a design to alleviate the oscillating shock and unsteady flow phenomena. Specifically, ground tests at AEDC are necessary to demonstrate the validity of concept/designs which would eliminate the flow instability. The offeror should be familiar with the Gasjet design and data base. He/she should have experience in the ground test diagnostic/instrumentation. A review of flight data may be required to see if this flow instability would indeed have adverse affects upon reentry vehicle performances. The offeror should quantify these instability effects from flight data if possible.

AF89-219. TITLE: Constructing Radiation Hard Semiconductor Devices on Advanced Substrates

OBJECTIVE: Design, build, and validate a demonstration chip capable of operating in radiation environments.

DESCRIPTION: The following programs are of interest:

a. Constructing Transistors on Doped Diamond Film: As the complexity of advanced reentry systems increases, the necessity for higher levels of integration grows as well. Once integration reaches an optimum level, further payoff is extremely hard to come by due to the requirement for heat sinks. The high thermal conductivity of diamond like coatings (DLCs) makes building semiconductor devices on such substrates more attractive as the level of integration increases. Additionally, the low power consumption and radiation hardness of such devices is desired. This effort will focus on constructing transistors on doped DLCs.

b. Increasing Neutron Tolerance of Analog Devices Built on SIMOX Substrate: The high level of neutron fluence postulated for the reentry mission poses a severe problem for analog devices. One way of coping with the attendant radiation environment is through the use of insulated substrates such as SIMOX. However, the structural damage caused by neutron irradiation still persists and must be addressed even for advanced substrates. This effort will focus on radiation hardening analog devices constructed on advanced substrates with the primary objective of increasing tolerance to neutron irradiation.

AF89-220. TITLE: Plasma and Optical/RCS Effects

OBJECTIVE: Develop techniques to investigate, model, or measure plasma effects and body and wake signatures of reentry objects.

DESCRIPTION: The following programs are of interest:

a. Reentry Body Radar Cross Section: Techniques are sought to estimate reentry body radar cross section. The radar frequencies range from 0.15 GHz to 12.5 GHz and at all possible target aspect angles. Both monostatic and bistatic radar should be considered. The body geometry is blunt cone with rounded bases and with body lengths of 20 to 250 cm. The body surface can be conducting, with dielectric layer or surface impedance. Specifically computer codes are sought for estimating the effects of: (a) antenna window; (b) plasma sheathing; and (c) 3D configuration effects.

b. Body/Wake Optical Signature. Simple and accurate methods are sought to estimate the body/wake/plume optical signature of a reentry vehicle (RV) particularly in the near IR, visible and ultraviolet regimes. Improvements and upgrade on the state-of-the-art technologies (e.g., the optical signature code, standard infrared radiation model, etc.) in the areas of robustness, versatility, computer speed, propellant variations and accuracy of data input are particularly encouraged. The offerors should be familiar with the industry-standard methodologies and review the limitation and weakness of those formulations. The missing information on the existing data bank for the emissivity and other optical properties of radiating gases and particulates should also be identified. Approaches to eliminate those deficiencies should be proposed.

c. RV Flight Test Plasma Measurement Instrumentation: Develop methods to measure plasma levels (electron densities, boundary layer thickness, and collision frequency) on a RV during reentry. Currently, indirect methods such as electromagnetic interactions are used to estimate plasma levels. However, techniques, such as Langmuir probes, are needed to provide some direct measure of these quantities. Regimes of validity (e.g., laminar flow vs turbulent) for the particular method or methods chosen must be clearly identified.

d. Fast Boresight Error Computer Code: In order to perform Monte Carlo six-degree-of-freedom digital simulations of homing RVs, a more general and efficient algorithm for calculation of on-line phase shift and attenuation due to plasma is needed. Current techniques involve either massive look-up tables or simple algorithms. These tables are generated at enormous computational expense and are good for only one particular antenna and limited frequencies. The simple algorithms are based on such concepts as thin layer theory which can easily handle variations in antenna geometries but are overly restrictive in terms of the allowable plasma layer thicknesses and densities. Codes developed for this purpose should be applicable to a wide range of antenna configurations, frequencies, plasma properties, transmitted polarization, etc.

e. Plasma Properties Data Base: The frequent use in the reentry community of plasma data suggests the need for the development of a semi-empirical plasma properties data base. Such a data base would be extremely useful in preliminary design, simulation, and research activities in the reentry vehicle community.

The objective of this SBIR effort would be to generate a comprehensive document on reentry vehicle plasma properties. This document should reflect all pertinent ground and flight test data and employ state-of-the-art computational techniques and incorporate this data into a semi-empirical methodology suitable for making rapid, approximate estimates of plasma properties. The semi-empirical methodology developed should be appropriate for both graphical (or tabular) and computer based implementations. This data base should

provide means for determination of all plasma properties of interest including profiles of electron density, collision frequency, temperature, and associated integral parameters.

AF89-221. TITLE: Site Characterization

OBJECTIVE: Develop remote or on-site methods to determine engineering site characteristics.

DESCRIPTION: The following programs are of specific interest:

a. Develop remote techniques for geotechnical site characterization. Create new or adapt existing remote methods of areal study for application to investigation of locations not available for on-site study. Current geotechnical site characterization methods are dependent upon on-site studies to determine suitability of a location. On-site methods can be costly, yielding detailed information which may or may not indicate sufficient information; gathered early in analysis, for elimination of noncompatible sites, can reduce time and cost of location suitability studies. This effort shall focus on methods of interpretation and analysis of satellite and airborne imagery, photographic and geophysical methods, and on the utility of combining any or all methods into an integrated method for remote characterization. Phase I activity will include feasibility studies with each method assessed as to accuracy, availability, cost, and resulting data. Phase II will develop and test the most promising techniques identified in Phase I.

b. Develop on-site techniques for geotechnical site characterization. Create new or adapt existing methods of on-site study using surficial and intrusive techniques to fully characterize the subsurface environment of a site. Standard procedures often rely on the use of a single method of site evaluation, such as multiple boreholes spaced throughout a location, requiring a large budget to be expended for characterization of a single location. Well developed and state-of-the-art nonintrusive and intrusive geophysical and geological methods should be studied in an effort to properly combine their use in a cost effective program of on-site geotechnical investigation. Emphasis shall not be limited to currently available methods but shall include applications of techniques not in standard use. Phase I will evaluate existing methods and develop the formulation of new concepts. Evaluation criteria shall include availability, quality of resulting data, and cost. Phase II will develop and test the most promising techniques identified in Phase I.

c. Develop techniques for estimating subsurface conditions prior to on-site study. Published information is not always available, or of the detail necessary for site characterization use. Develop methods of parameter extrapolation. The parameters of interest shall include, but are not limited to, geohydrologic regime, subsurface rock temperature, rock mechanics, and dynamic structures. Phase I will include a survey and analysis of techniques currently in use or proposed for use and methods considered suitable for characterization use shall be identified. Phase II will develop and test the most promising techniques identified in Phase I.

d. Advanced basing options offer cost effective basing options involving very high hardness through the use of beneficial siting. Current siting data for evaluation of advanced basing is based on limited field test data. These evaluations require a rapid method of site survey of a given area to ensure constructability and hardness potential. Remote sensing technology is

available to rapidly acquire certain type of site characteristics that could significantly augment the available data and simple intrusive site testing. An automated methodology could expedite the evaluation and maximize the synergistic relations and benefits of various siting data. Phase I of this effort is intended to provide an evaluation of remote sensor and platform capabilities, and identification of a plan to develop an automated methodology to interpret both remote sensor and on-site/intrusive data. Phase II will develop the methodology with a focus on evaluating specific site characteristics such as dry soil properties and water/rock depth to water/rock for a given site. Validate the methodology through a simple test.

AF89-222. TITLE: Hardened High Voltage Power Supply for Ring Laser Gyros

OBJECTIVE: Design, build, and validate a high voltage power supply for a ring laser gyro.

DESCRIPTION: A ring laser gyroscope requires a voltage on the order of a few kV for start up excitation of the HeNe laser. The voltage level needed drops substantially after start up. During a reentry vehicle mission, the power supply may undergo on/off switching for circumvention of nuclear effects. In addition, the power supply must be able to withstand the radiation environment associated with the reentry mission. Requirements for this effort include designing, building, and validating a radiation hardened high voltage power supply for a ring laser gyroscope. Particular attention should be paid to keeping size, weight, and power consumption to a minimum.

AF89-223. TITLE: Packaging Techniques to Reduce Radiation Effects on Electronics

OBJECTIVE: Develop packaging techniques for circuit boards to alleviate radiation effects on reentry vehicle (RV) electronics.

DESCRIPTION: During RV flight, a high level of nuclear radiation will be incident on the vehicle and the onboard electronics. A potentially effective way of limiting nuclear induced circuit degradation is through the use of advanced packaging techniques to shield the radiation at the device and circuit board level. Not only are total dose and neutron irradiation a problem but one must also prepare for the inevitable EMP. This effort should focus on the reduction of radiation induced degradation through shielded packaging of the devices and circuit boards.

AF89-224. TITLE: Improved Basing Security, Safety, and Reduced Manning

OBJECTIVE: Develop techniques to improve ICBM security, safety, and reduce manning.

DESCRIPTION: Current mobile systems and several advanced basing systems introduce added problems of nuclear security, safety and increased manning as a result of mobility. From the stand point of security the basing systems can be classed (1) as area secured where the public interface is removed from the missiles by security fences and other security measures and (2) as point secured with close-in public interface in open public land areas. Passive security measures such as a variety of sensors and surveillance devices have the advantage of reducing manning requirements but suffer from the problem of

high false alarm rates or low probability of detection. Active security measures involving security and strike teams can be effective, but require increased manning to achieve the required degree of security. Mobile options requiring launchers to be in alert mode increase the manning requirements because of the needed rotation of large numbers of personnel. Phase I will investigate concepts to provide significant improvements in security, safety, and manning of advanced basing systems. These concepts might involve improved sensor and/or protective measures, automation, and other techniques. Phase II will develop the most promising options for specific basing concepts in detail.

AF89-225. TITLE: Signature Countermeasures and Tag/Implant Sweep Techniques

OBJECTIVE: Develop signature mitigation countermeasures and methods of locating implants/tags.

DESCRIPTION: Potential advanced ICBM basing systems achieve high ICBM survivability through mobility and concealment of missile locations in a secured area or in open public areas. In a secured area a large class of threat sensors that could locate the missile locations are eliminated by stand-off distance. Areas of concern for these systems are (a) leakage of location information through internal agents, (b) location of missile positions by long range threat sensors, and (c) through the use of tiny implants or tags that could be deployed in any phase of missile/basing deployment life. These problems can be more severe for systems utilizing unsecured areas with public interface. Concepts for countering the missile/launch/facility seismic vibration, acoustic, and thermal signatures and methods of detecting/locating implants tags are sought. Phase I will explore one more of these issues with several alternate solutions. Phase II of the effort will develop specific solutions through laboratory or small scale test experiments.

AF89-226. TITLE: High Temperature Insulator

OBJECTIVE: Develop an insulative layer that would reduce the space occupied by current carbon phenolic heatshields.

DESCRIPTION: An acceptable insulative layer would, as a minimum, meet the following requirements.

a. Hot side temperature - 5000 deg Fahrenheit.

b. Cold side temperature - 400 deg Fahrenheit after 20 sec.

c. Minimum thickness - less than 1/2 inch.

d. Formable into conic shells.

e. Capable of transferring mechanical loads without insulative loss.

The intended use of this insulator is, on reentry vehicles, to reduce the space occupied by current carbon phenolic heatshields in severe environment regions.

AF89-227. TITLE: Development of a Heatshield

OBJECTIVE: Develop a heatshield with adequate structural strength and integrity in the presence of a large antenna window.

DESCRIPTION: The tape-wrapped carbon phenolic heatshields used on ballistic reentry vehicles depend on circumferential continuity for strength. The same quality of heatshield is needed for maneuvering reentry vehicles (MaRVs). Some of the MaRVs require large antenna windows for accurate guidance. These windows require large cutouts (12 x 12 inch min.) in the heatshield, resulting in a disruption of the circumferential wrap over a significant distance. This program would evaluate the consequences of these large cutouts on structural survivability and develop corrective solutions.

AF89-228. TITLE: Non-Destructive Tests and Evaluation (NDT&E) Techniques for Rocket Motors

OBJECTIVE: Develop portable NDT techniques and analytical models for defect/effect evaluation.

DESCRIPTION: Non-destructive test techniques for investigating defects in solid rocket motors, nozzles, cones and other propulsion components are useful during manufacturing, acceptance and static and dynamic testing. Several techniques are in use which require extensive handling of heavy articles at certain facilities. There is a need for development of new methods for portable NDT techniques that could be rapidly and more conveniently used to support on-site fabrication, field testing (particularly the dynamic measurements), aging and surveillance as well as investigations of internal surfaces of large rocket motors. Another issue of concern is the lack of suitable engineering methods for the evaluation of effects of critical defects such as liner debonds and propellant voids on the structural and ballistic performance of rocket motors. Engineering evaluation methods are also needed to evaluate the effects of fabrication and material defects in the carbon-carbon nozzles on nozzle performance. Current methods for such evaluations are based on somewhat subjective assessments, experience of specific people and limited tests. These evaluations and data base are expected to become less useful with time because of rapid changes in materials designs and manufacturing techniques and retirement of experienced evaluators. Current methods therefore need to be augmented with suitable engineering analyses and test methods that can take advantage of computer and material modeling techniques. This effort is aimed at the development of automated engineering evaluation methodology. An evaluation of available performance codes and the definition of other analytical models for predicting structural and ballistic performance of propulsion systems accounting for the effects of defects is required. This effort includes investigation of methods of characterizing material properties with degradations due to defects. Phase II effort will develop computer codes for modeling material properties.

AF89-229. TITLE: Rocket Motor Test and Display Techniques

OBJECTIVES: Develop methods for testing grain burn back, insulation, and nozzle erosion rates.

DESCRIPTION: In the rocket performance testing, critical information on certain parameters is difficult to obtain and display. Examples of some of

the critical measurement issues include rocket motor grain burn back, insulation erosion, nozzle throat erosion and particle distribution in rocket exhausts. This effort is aimed at the definition and evaluation of concepts leading to the development of dynamic measurements and/or display techniques for rocket testing. This effort will investigate techniques to obtain 2 or 3 dimensional topological mapping of grain burn back patterns and slag formation, insulation erosion characteristics, nozzle throat erosion rates and patterns and dynamic characterization of particle size and velocity distribution of condensible species. For the rocket exhaust, the capability to survey complete transectional scanning from the nozzle exit radius to the motor centerline is required to evaluate particle velocity lags. Phase II effort will design and test the most promising techniques.

AF89-230. TITLE: Sounding Rocket Thrust Vector Control

OBJECTIVE: Design a thrust vector control system for previously-fixed nozzle sounding rocket motor systems.

DESCRIPTION: The purpose of this effort is to design a low cost system to provide thrust vector control of previously-fixed nozzle sounding rocket type motor systems. Requirements exist to reduce impact dispersion areas, increase altitude, and allow the use of high performance motor systems on enclosed missile ranges. Thrust vector control of the vehicle system during boost will greatly reduce impact dispersions by reducing wind effects on the vehicle during the initial slow moving launch phase. A thrust vector control system will also correct nozzle offsets and misalignments and provide for trajectory control. This effort will include trade-offs of gimballed nozzle approaches, jet vane techniques, air vane concepts, nozzle injection methods, and combinations thereof. Typical motor boosters include Talos, Sergeant, Hydac, Apache, Orion, Nike Terrier, Nihka, Honest John, Castor I, Castor II, Castor IV, Black Brandt 3, and Black Brandt 5. The will identify the type of control system best suited for those motors selected. Control system packaging shall also be considered, the optimum approach being to self-contain the system including power, actuators, vanes (if needed), housekeeping and position sensors, and thermal protection. Command signals will be provided to the control system via the payload attitude control system. The system must also be capable of operating in conjunction with fixed fins which are required for those systems that burn out while still in the effective atmosphere or have long coast phases between stages. Phase I will include conceptual design studies for various boosters. Phase II will develop the thrust vector control system designs for chosen booster systems.

AF89-231. TITLE: Integrated Case Structure/External Protection

OBJECTIVE: Develop design concepts for case structure/external protection to increase strength/stiffness and Directed Energy Weapon (DEW) hardness.

DESCRIPTION: Future mission requirements for booster structures include increased measures for external protection against dust and pebbles as well as protection from DEWs in a layered defense threat environment. Structural requirements for strength and stiffness may also increase along with flight load environment for missions such as fast burn boost. This effort is aimed at the investigation of design concepts for motor cases and boosters that will offer significant improvements in the structural strength and stiffness to weight ratios and protection to weight ratio. These concepts could include

improved filament wound materiel/fabrication technology, resin density reduction, conical cases, improved protection systems for nuclear and DEW environments, and integrated protection/structural systems. Phase II will analytically and experimentally evaluate the most promising concepts.

AF89-232. TITLE: Sounding Rocket Telemetry/Tracking System

OBJECTIVE: Design a single telemetry/tracking system to provide S-band telemetry.

DESCRIPTION: The purpose of this topic is to design a transportable system to receive telemetry data, determine actual trajectory, provide uplink control of payloads, and provide flight termination capability. Two systems will be required to satisfy the range safety requirements for redundancy. Each system will consist of an antenna(s) mounted to a two-axis pedestal. The data will be passed to recording and data analysis equipment mounted in an equipment shelter. A suitable computer will provide slant range, rocket trajectory,and projected impact zones for range safety. System requirements and accuracies will be determined as a part of this effort. The trackers will be located at the launch point. Pedestal equipment will be operated without a radome in winds up to 50 mph and surviving winds up to 120 mph. Dynamic tracking accuracy will be better than 0.2 x RMS at 15 x/sec † target accelerations. Static pedestal accuracies will be better than 0.075 x in each axis. Slant range accuracy will be better than 250 meters at maximum slant range. The operational environments include rain, snow, ice, deserts, mountains, and coastlines. Downlink telemetry will be up to 750 KBPS on an S-band carrier. The telemetry will provide sufficient signal-to-noise ratio to exceed a bit error rate of 10^{-5} for all standard IRIG telemetry links. The receiving system will be capable of demodulating all IRIG standard rf signals. The uplink data will be on a UHF carrier with capabilities for payload attitude remote control and actuation of flight termination hardware. Sufficient rf link margin must exist to a distance of 1200 km slant range. The Phase I effort will consist of several trade-off studies to determine the optimal telemetry and tracking systems configuration. Trade-off studies will include receive antenna size, ground uplink antenna, slant range measurement system (CW vs. pulsed vs. PCM), transmitter power, trajectory computer (micro vs. mini), equipment enclosure and included data analysis equipment, methods to minimize station activation and alignments, programmable antenna controllers, transmit and receive equipment, and other test equipment. Phase I should result in identification of conceptual systems. Phase II will result in the complete conceptual design of a chosen system.

AF89-233. TITLE: Sounding Rocket Airborne Instrumentation System

OBJECTIVE: Design an airborne instrumentation system to obtain aging and surveillance data for sounding rocket boosters.

DESCRIPTION: This effort will design an airborne instrumentation system to collect solid propellant rocket motor performance data with respect to aging and surveillance. Current sounding rocket booster systems rely heavily on relatively old, government surplus, solid rocket motors. These motors, poured in the 1960's and 1970's have aged beyond the recommended life of the propellant. However, due to their availability and cost, they are still being used. As these motors age, their performance and reliability have shown deterioration. In order to better predict the future performance of these systems,

there is a need to evaluate the current performance of these motors.

This effort shall design a self-contained aging and surveillance system (sensors, cables, PCM encoder, transmitter, power, and antennas), that with minimal payload interface (internal/external control and on/off control) can be used to obtain diagnostic data on these motor systems. The effort shall identify parameters to be measured including ignition delay, ignitor pressure, chamber pressure, steady-state longitudinal acceleration, high rate triaxial shock and vibration data, head cap and nozzle temperature data, and strain gage data at various points on the motor. This data will be used to predict average thrust, burn time, total impulse, and tail off and to better determine environmental test levels for sounding rocket payload systems. The effort shall also determine instrumentation to be used with standard IRIG PCM formats and the required scaling levels or ranges for such instrumentation. The PCM encoder system and transmitter shall be compatable with standard IRIG S-band receiving and decommutation equipment. Phase I will include conceptual design studies for a proposed system. Phase II will result in a complete conceptual design for an airborne instrumentation system.

AF89-234. TITLE: Fiber Optics Ordnance

OBJECTIVES: Investigate and develop improvements in the performance, testability, and hardness to nuclear weapons.

DESCRIPTION: The newly developed concept of fiber optics ordnance is currently being implemented in the SICBM development to provide improved reliability, testability and hardness. Further developments are needed in terms of more efficient performance, ease of testing and improved ionization resistance to nuclear weapons effects. This effort is aimed at improving the design efficiency, exploring the potential for fiber laser using doped fiber, exploring electro-optic switching using high voltage non-linear crystals, and exploring a fiber optic beam reducer in a laser fiber optic ordnance system. Performance improvements may involve improved initiator, more efficient coupling between the initiator and optical fibers and improved beam in laser fiber optics system. Phase II will develop and test one or more of the promising solutions.

AF89-235. TITLE: Development of New Scientific Research Instrumentation

OBJECTIVE: To stimulate the development of new scientific instruments for laboratory and industrial applications.

DESCRIPTION: Progress in fundamental research often depends on use or invention of new diagnostic techniques which can provide better insight into the fundamental processes or phenomena under study. Development of improved and novel scientific instrumentation will enable researchers to make more useful measurements per unit of time, to make measurements to a greater degree of accuracy, and to make measurements in places and under conditions not now possible. It may also permit quality instruments to cost less and be more reliable. This effort seeks to improve the basic function of scientific instruments, and to reduce the cost and improve the reliability of instruments which would enhance the scientific productivity of this country. Areas of interest include, but are not limited to, laser combustion diagnostic testing, vision testing equipment, advanced biogenetic tests for toxicity, new mathematical algorithms allowing improved computer program performance, optical

information processing, accelerator mass spectroscopy, aerodynamic flow measurement devices, and improved material and process diagnostic systems. The Phase I effort should provide a review of various concepts and design options for the proposed type of scientific instrumentation. The Phase II effort would then develop a prototype or prototypes of the best/concept design alternatives, leading to Phase III commercialization of the instrument. Evaluation of proposals will include the following factors: (a) potential value to the Air Force Research program; (b) potential for transition to Air Force Laboratories; and (c) potential to aid the scientific community.

AF89-236. TITLE: Development and Application of New Theories and Concepts Relating to Fluid Mechanics

OBJECTIVE: Improve understanding of flow to improve performance of Aerospace Systems.

DESCRIPTION: Areas of interest include computational fluid mechanics, viscous and separated flows, and hypersonic aerothermodynamics. Research in computational fluid dynamics is needed to predict flow past complex, threedimensional shapes more efficiently and accurately. Procedures for exploiting new supercomputer architectures and solution adaptive grids are examples of current interest.

Research in viscous and separated flows includes such topics as interactions of strong shock waves with turbulent boundary layers; methods for analytically examining higher order, inviscid flow coupling; and the nature of large-scale organized separations that frequently occur on low-aspect-ratio aerodynamic shapes at high incidence. Research issues associated with fluid dynamics and controls coupling are included. Research in hypersonic aerothermodynamics should improve understanding of strong viscous interactions with and without real gas effects.

For Internal Flow Dynamics, the main focus is on the mechanisms limiting the performance of axial flow compressor, axial flow turbines and diffusers. Better flow prediction methods for modeling the effects of viscosity, turbulence, compressibility, unsteadiness and temperature variations are sought. New concepts for active flow control in the turbomachine environment are encouraged.

Unsteady flow research addresses the scientific basis for exploiting unsteady flow driven by time-dependent boundary conditions to improve aerodynamic performance, especially maneuverability. Current research centers on unsteady flow separation and dynamic stall with emphasis on the mechanisms of vorticity production, accumulation and shedding. The effects of motion history, multiple degrees-of-freedom, and Reynolds and Mach numbers are of interest.

Collaborative, interdisciplinary approaches involving fluid dynamics and control theory are desired to provide new approaches for controlling turbulent and unsteady flows.

AF89-237. TITLE: Development and Application of New Theories and Concepts Relating to Structures

OBJECTIVE: Improve structural efficiency and durability.

DESCRIPTION: We are particularly interested in the role of nonlinearity in structural response and in the ability to control the behavior by active and passive means. The dynamic response to external stimuli such as aerodynamics, gust and impact loads and complex interactions with fluids and control subsystems are of major interest. We seek the capability for accurate modeling of thermal diffusion through multilayer actively-cooled structures including consideration of aerothermodynamic heating and surface reactions in hypersonic flight.

We support development of advanced constitutive theories capable of modeling the behavior of advanced materials such as polymeric, ceramic, metal matrix and carbon-carbon composites. Consistency between micro- and macro-structural viewpoints and accommodation of progressive damage are desirable attributes in this regard.

Special emphasis is placed on innovative interdisciplinary approaches combining materials science and solid mechanics and aimed at bridging the gap between the microstructure and the macro-mechanical material behavior.

Emphasis is also placed on damage growth predictions and physically identifiable and measurable damage metrics. Probability aspects of damage growth and failure are pursued by considering the development of damage states as a stochastic process.

A significant portion of this research addresses composite materials for propulsion and hypervelocity flight structures, including airframe composite laminates; solid rocket fuel particulate composites; and very high temperature ceramic and carbon-carbon composites.

Research areas include micromechanically based, constitutive modeling of soil, concrete and rock; identification and in situ measurement of properties of soils; identification of the mechanics of soil stabilization; investigation of blast-induced soil liquefaction; study of the strength and fracture characteristics of geological materials; modeling of the response of jointed and monolithic rock formations; identification of damage mechanisms in concrete materials; investigation of structural systems for expedient facilities; study of the nonlinear structural response to high frequency dynamic loading; and investigation of structure-media interaction.

AF89-238. TITLE: Development and Application of New Theories and Concepts Relating to Propulsion

OBJECTIVE: Improve the efficiency and stability of propulsion systems.

DESCRIPTION: Fundamental understanding of the physics and chemistry of multiphase turbulent reacting flows is essential for improving the performance of airbreathing propulsion and chemical laser systems.

We are interested in original and innovative research proposals using simplified configurations for experimental and theoretical investigations. Proposals to develop near-term, empirical, comprehensive models are not desired. We shall assign highest priority to research relevant to studying supersonic combustion, boron fuels, atomization and spray behavior of slurries and liquids, and understanding the chemistry of fuel combustion. Other topics of interest include, but are not limited to: turbulent combustion, soot formation and combustion instability.

Topics of interest in electro propulsion include pulsed and steady-state plasmas; equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, -electrode, -magnetic and -electric fields; losses to inert parts; plasmas in high magnetic fields and pressures; and plasma diagnostics (new and unique noninterference measuring techniques).

Our objectives are to predict and to suppress combustion instability in solid and liquid rocket systems, to control the complex roles of advanced energetic ingredients in solid propellant burning, to use metal fuels and to improve the service life of solid motors.

We are interested in new diagnostic techniques for analyzing surface reactions and flames of propellants, and in controlling the state of combustion products in plumes. Emphasis is on synthesizing and using advanced propellant ingredients to increase propulsion efficiency and to satisfy specific burning rate requirements.

Research is directed at new techniques for sensing temperature, concentrations and velocities in energy conversion systems without interfering with the operation of the systems. The emphasis is on diagnostics of laboratory systems that simulate the hostile environments of high performance combustion and plasma systems.

AF89-239. TITLE: Multifunctional Nonmetallic Materials Processing and Characterization

OBJECTIVE: To develop new nonmetallic material concepts for unique combinations of optical, electromagnetic and structural properties.

DESCRIPTION: Advances in ceramics, glasses and polymers are expected to come from the control of features at the 10-50A to 1000-10,000A level (ultrastructure) via chemical synthesis and processing methods. These materials may take the form of ultrastructural level composites which will perform a combination of active and passive functions. Processing includes new and improved materials based on the methods of organic, inorganic and organometallic chemistry as well as sol-gel, graphite-template chemistry, micromorphology processing, transformation processing, intercalation chemistry, emulsion chemistry and other innovative processes. Imaginative combinations of these processes are of interest for materials with nonlinear optical, magnetic, superconducting and/or semiconducting properties and phenomena and structural integrity. Subpicosecond, nonresonant or near-resonant low power optical polymers, organics and inorganics or combinations thereof or unique materials concepts for high critical temperature superconduction are specifically required. Molecular composites, which would include the analogs of macroscopic composites, biological and natural systems as well as new synthetic combinations, are of interest. Device applications should be considered, particularly where the ultrastructured material will serve as a self-contained functional entity. New organic and inorganic polymers as well as oxides and non-oxide nonmetallics are needed for these multifunctional ultrastructures. New mechanisms and reactions are considered important components of nonmetallic materials processing and synthesis.

AF89-240. TITLE: Atmospheric Science Modeling Technology

OBJECTIVE: To stimulate the development of new experimental and/or numerical methods for modeling atmospheric processes.

DESCRIPTION: Advances in capabilities for more accurate specification and prediction of the state of the atmosphere depend to a large extent on the fundamental understanding of underlying physical processes. There are so many variables in the real atmosphere that isolating various causes/effects of these physical processes often becomes difficult to nearly impossible in the natural environment. Development of physical laboratory models and/or computer models will enable controlled simulation of individual processes to uncover the mysteries of their basic evolution. An improved knowledge and larger-scale numerical modeling efforts, which could aid both the research and operational communities. This efforts seeks to enhance scientific research activities in the area of simulating lesser understood atmospheric processes. Areas of interest include, but are not limited to, gravity waves, lee waves, turbulence, convection, latent heating/cooling, and boundary layer fluxes. The Phase I effort should provide a review of various concepts and design the options for the proposed model(s).

AF89-241. TITLE: Neurocomputers, New Architectures and Models of Computation

OBJECTIVE: To stimulate development of new computer architectures that implement neural network/connectionist models of computation.

DESCRIPTION: Few neural network and connectionist models of computation can be implemented in real-time on any existing computers. New types of computers, neurocomputers, must be designed in order that real problems can be solved with neural networks. Our interest lies in two areas: general purpose and special purpose neurocomputer architectures. General purpose machines must be able to implement as many neural network models as possible, handling extremely large numbers of artificial neurons and interconnections in different configurations with various learning rules and knowledge encoding. Special purpose machines, neural network accelerators, are designed for a specific type of neural network model and, more likely, for a specific problem that is solved by a neural net. Such machines must easily solve a persistently difficult problem and readily interface with other non-neural net machines. For all types of neurocomputers, the use and integration of new technologies, such as optics and organic polymers, into both neurocomputer components and architecture is highly encouraged. For example, it is most likely that many different types of artificial neurons and interconnections will be necessary to implement many neural network models. This will promote the creation of neural network "building blocks" from which many of the above systems can be built. There is also some interest in integrating neural net machines with other more traditional types of computation such as artificial intelligence and database computers.

AF89-242. TITLE: Heterostructures: Materials and Devices

OBJECTIVE: To grow model, measure, understand and exploit electronic and electrooptic heterostructures.

DESCRIPTION: Relatively modern thin film growth technqiues such as molecular beam epitaxy (MBE) and metallo-organic vapor phase epitaxy (MOCVD) afford the

ability to grow electronic films of high purity and crystalline perfection. Such films include metals, semiconductors and insulators. Under appropriate conditions, one type of material can be grown epitaxially on another material; this is known as heteroepitaxy. More recently, heteroepitaxy has been extended to cases involving materials of differing crystal types and lattice constants. (GaAs on Si is an example of current interest). With these constraints lifted, within limits, many novel and potentially important electronic structures can be visualized.

Research is sought in the electronic applications of heteroepitaxy and heterostructures. This includes theoretical studies of the initial and subsequent phases of heteroepitaxy; materials growth studies involving electronic semiconductors, metals and insulators; the characterization of surfaces and heterointerfaces; and the design and fabrication of electronic devices incorporating heterostructures. Examples of materials of particular interest include compound semiconductors such as the III-V and II-VI families, (e.g., GaAs and ZnSe). Devices of interest include artificial superlattices, quantum well structures, and electrooptic structures such as solid state lasers.

AF89-243. TITLE: Life Sciences Basic Research

OBJECTIVE: To provide fundamental data in toxicology, neurobiology, sensory information processing, and cognitive sciences.

DESCRIPTION: Basic research in five areas is supported:

Toxicology: Emphasis is on fundamental mechanisms that organisms use to respond to toxic chemical exposure, especially chemicals to which Air Force personnel are exposed. Primary objectives are to identify early indicators of toxic insult, to elucidate the mechanism of action of toxic chemicals, and to enhance natural detoxification of environmental chemicals through conversion of toxic agents into nontoxic metabolites.

Neuroscience: Fundamental studies of the neurobiology of learning and memory, biological rhythms, fatigue, stress, and arousal are one area of emphasis. Proposals for neurobiological research in which behavior is not studied explicitly but which would clearly further the understanding of behavior are accepted. Neurobiological research on visual and auditory information processing and higher cognitive functions and studies that bring together information about cellular and neural-circuit functions with information from studies of artificial intelligence are also supported. The relationship between neural architectures and formal computations that might underlie goal-directed behavior, learning, memory, and pattern recognition is emphasized.

Vision: Psychophysical research is supported leading to the discovery and quantitative modeling of featural processing mechanisms underlying visual recognition. Contrast detection and discrimination, motion, eye-movement, color, and stereopsis are examples.

Audition: Psychophysical research is supported on the perception of complex sounds in normal human adults. The mechanisms underlying recognition, pitch, localization, and speech are examples.

Cognition: Research is supported on cognitive aspects of perception, memory, learning, representation of knowledge, problem-solving, reasoning, and judgment.

AF89-244. TITLE: Research in Mathematics and Computer Science

OBJECTIVE: To stimulate innovative approaches to mathematical modeling, computation, design, and control for complex systems.

DESCRIPTION: The Air Force needs improved analytical and computational approaches to modeling, design, and control of complex systems occurring in many fields of application, including aerospace structures, robotics, electro-magnetic propagation and fluid flow. Enhanced computing methods and artificial intelligence will have a significant impact on our ability to design and control physical systems.

Basic research is required in several areas related to this topic. Mathematical models are required for many of the systems of interest, including those occurring in propulsion, robotics, and laser optics. Effective mathematical understanding, using both analytical and numerical tools, is needed for nonlinear equations such as those for transonic flow, laser focusing, detonation, stability of shear flows, geometrically exact elasticity, and nonstandard viscoelastic media.

Capabilities for solving the partial differentiable equations modeling physical systems need to be vastly increased. This calls for research in computational mathematics, especially related to solving such problems on parallel architectures. Improvements in parallel computing environments as well as methods for dynamically mapping algorithms on to parallel architectures are needed.

Research is needed in several areas of mathematical control theory, including adaptive control and distributed parameter control. Research should address novel methods for dealing with nonlinear dynamics as well as model uncertainty and robustness. Research should focus on the mathematics of dynamics and control in areas applicable to control of systems occurring in large space structures, robotics, or control of fluid flow and combustion processes.

Artificial intelligence approaches may be combined with control theory in order to control complex decentralized systems. Research in intelligent control methods, which couples these two approaches, is needed.

Advances in software engineering and knowledge-based systems will be needed to implement computational models and control algorithms. Research is needed in knowledge-based systems with improved mechanisms for temporal reasoning for application to real-time critical problems. Research in software engineering should address issues of reusability, better programming environments, and the need to monitor changes dynamically.

Future Air Force operations will require more effective methods for the design of complex systems and the optimization of design with respect to performance and life-cycle costs of the system. Research in optimization is needed to develop the mathematics necessary to support and implement design optimization and control. As part of this process, research in optimization of infinite-dimensional systems is needed; this has applications to such areas as structural design and integrated structural and control design. In order to

ensure reliability of these systems, new approaches are needed for statistical reliability analysis of complex systems.

Research in any of the above topics should stress fundamental and innovative research in mathematics or computer science and should have as a goal advancing the state of knowledge in those fields.

AF89-245. TITLE: Novel Techniques in Seismic Detection

OBJECTIVE: To devise new techniques or instrumentation for improved seismic detection.

DESCRIPTION: Seisometry is based upon using seismometers which represent mature and perhaps dated technology. The goal is to incorporate new high-technology techniques and instrumentation to devise innovative detection schemes which improve accuracy, sensitivity, and/or frequency response to seismic signals.

AF89-246. TITLE: Novel Electron-Beam-Driven Devices for the Generation or Amplification of Millimeter-Wave Radiation

OBJECTIVE: To advance the state-of-the-art in compact, efficient, high power, mm-wave vacuum electronics.

DESCRIPTION: The Air Force is the single largest customer in this nation for vacuum electronic microwave devices. In spite of the popularity of solidstate devices, there are numerous applications in communication, radar, and electronic warfare whose power requirements exceed the capabilities of available semiconductors. The current Air Force and DOD investments in R&D in vacuum electronics has been miniscule for over two decades. This situation has impeded the rate of innovation in the microwave tube industry. At the same time, more demanding DOD requirements are putting increasing pressure on the industry to produce more compact, more lightweight, more efficient, and more reliable microwave tubes. In addition, future applications are expected to require tube output at higher and higher frequencies. The shorter the wavelength of radiation desired; the more intricate and expensive are the required fast wave tube structures. New tube concepts and geometries are needed to meet these future needs. In addition, the physics involved with beam-plasma interactions offer alternative mm-wave device concepts that beg exploration. Phase I efforts should provide a solid theoretical foundation for the new mm-wave amplifier or oscillator concept. Preliminary device design should also be addressed. Phase II should result in the design and construction of an actual prototype device along with preliminary performance optimization studies. Phase III should see the commercialization of the device concept.

AF89-247. TITLE: Infrared Astronomy

OBJECTIVE: Improve dispersion optics for ten micron mosaic detector arrays.

DESCRIPTION: The operation of mosaic detector arrays in the ten micron spectral region on large, ground-based telescopes provides stellar images near one arcsecond resolution, but such systems must cope with the large thermal backgrounds from the atmosphere and the telescope. During operation of avail-

able mosaic detector arrays in this spectral region with a 0.1 micron spectral bandpass and one arcsecond pixel field of view, the pixel charge integration sites approach saturation at the highest permitted frame rates. Such a 0.1 micron spectral bandpass results naturally when the 8 to 13 micron region of atmospheric transmission is covered simultaneously across one axis of existing 64 pixel square mosaic arrays, which is desired to minimize corruption of the stellar spectrum by temporal changes in atmospheric transmission. A need therefore exists for an optical design for which the dispersive element (prism or grating) spreads the 8 to 13 micron spectrum across the 64 pixels, but at a spectral bandpass near 0.01 micron per pixel. Discrete tilts of one of the optical elements would then result in an approximately uniform, sequentially sub-sampled spectrum at 0.02 micron sampling interval. Required design attributes include operation near 4 degrees absolute temperature, rejection of radiation outside the f/27 telescope beam, overall transmission approaching 50%, and construction/alignment capability without recourse to exotic materials or technqiues. As an optional requirement, the offeror is invited to consider simple fore-optics at the telescope focus which would minimize the effects of atmospheric turbulence on the spatial position of the star on the mosaic array.

AF89-248. TITLE: Emerging Technologies Resulting in Lighter Aircraft, Increased Engine Performance, and Improved Design Tools

OBJECTIVE: Improvements in Aircraft Structure, Scramjet, and Aerodynamic Design Technologies.

DESCRIPTION: The National Aero-Space Plane is providing a quantum jump in aerospace technologies by investigating new and innovative solutions. Its goal is a Mach 25 air breathing scramjet vehicle capable of single stage to orbit. Emerging technologies providing significant performance improvements for the aircraft will be considered. Phase 1 must show experience and understanding of the relative importance of the technologies. It must also provide detailed drawings, specifications, and test procedures for the proposed technologies. Phase 2 requires prototypes and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased liabilities.

AF89-249. TITLE: Hypervelocity Space Vehicle Interactions and Signatures

OBJECTIVE: Prototype flight sensors to measure aircraft/engine radiance and emissivity.

DESCRIPTION: Sensors are needed to measure electromagnetic radiation and chemical emissions on hypersonic aircraft. Sensors should be capable of measuring fuselage, engine, exhaust, outgasses, or plasma sheath electromagnetic spectrums (in the infrared, visible, or ultraviolet ranges). Phase 1 must demonstrate understanding of the phenomenon, sensors, and applications. It must provide detailed designs of the proposed sensor and the test procedures planned for proving the concept. Phase 2 produces the prototypes, test results, and then analyzes the data against prediction performance.

AF89-250. TITLE: High Temperature (2000+ C) Instrumentation

OBJECTIVE: Prototypes and associated test results of high temperature (2000+ C) dynamic pressure, strain, temperature gages and/or acoustic microphones.

DESCRIPTION: High temperature (2000-5000 C) instrumentation is required for testing the materials, structures, and aerodynamics of hypervelocity vehicles. Specifically dynamic pressure, strain, temperature gages and/or acoustic microphones need to be developed and tested. Such instruments could be used in ground based facilities or eventually developed into flight weight systems for hypervelocity research aircraft. Phase 1 efforts need to demonstrate experience and knowledge in high temperature instrumentation as well as detailed designs for a prototype. Phase 2 must produce prototypes and test.

AF89-251. TITLE: High Temperature Fasteners and Attachment Techniques

OBJECTIVE: Prototype fasteners, specifications, attachment techniques and experimental test results.

DESCRIPTION: High temperature (2000-5000 C) structures are composed of components which need to remain attached together. In structural testing this includes attaching strain gages to test specimens. Carbon/Carbon, Ceramic Matrix, and cooled Titaniums are examples of high temperature structural components requiring attachment to one another. The Phase 1 efforts need to show knowledge/experience in fasteners and attachment techniques in addition to detailed designs for the fasteners. Phase 2 must proceed to develop the prototypes and test.

AF89-252. TITLE: Kinetics Turbulence Interaction in Reacting Flows

OBJECTIVE: Kinetics turbulence computer codes for reacting flows.

DESCRIPTION: Hypervelocity (Mach 6-25) aerodynamic simulation requires further refinement of the kinetics and turbulence models for the reacting flows of the air stream. Phase 1 must show an understanding of the state of the art in simulation and the kinetic turbulence interactions. Phase 2 must provide the computer code describing the turbulence.

AF89-253. TITLE: Finite Rate Chemistry Algorithms for Hypersonic Flows

OBJECTIVE: Improved computer algorithms for the finite rate chemistry in hypersonic flows.

DESCRIPTION: Hypervelocity (Mach 6-25) aerodynamic simulation requires improved algorithms to describe the chemistry in the air flow. Improvements in the finite chemistry calculations are of specific interest.

AF89-254. TITLE: Global Communication Strategies for Hypersonic Vehicles

OBJECTIVE: Improved test control strategies and centers for hypersonic flight tests.

DESCRIPTION: Testing hypervelocity (Mach 25) vehicles provide a new problem to traditional aircraft test ranges. The higher speed vehicles no longer

remain within the confines of the range, or even the country, but still require continuous communications and telemetry. Phase 1 studies must describe available systems and those planned to be operational by May 1995. The studies should show how the appropriate systems could be integrated to form a single point test control center. Phase 2 should form a demonstration single point test control center and exercise the the world-wide telemetry and communications.

AF89-255. TITLE: High Temperature Non-Intrusive Diagnostic Instruments for Flow Field Measurements (with and without chemistry)

OBJECTIVE: Prototype instruments with test results demonstrating their sensitivity and accuracy.

DESCRIPTION: Non-intrusive diagnostic instruments and techniques are required for experiments with high temperature (2000-5000 C) aerodynamic flow fields. The instrumentation must be capable of working in flow fields with chemistry as well as those without chemistry. Phase 1 should demonstrate knowledge of existing measurement techniques and provide detailed drawings of proposed new or improved instruments. Phase 2 must build and test prototype instruments.

AF89-256. TITLE: Visibility Requirements for Non-Instrumented Landings

OBJECTIVE: Minimum visibility requirements and the supporting statistical analysis of experimental studies.

DESCRIPTION: All aircraft limit the pilot's external field of view to some degree, but the minimum field of view required for non-instrumented landing an aircraft is undefined. Non-instrumented landings are manual landings using only aircraft performance indicators and visual cues of the approaching landing strip. They do not depend on any automated landing devices, communications, or external sensors such as radar. Research is required to identify the minimum field of view required. Experimental results and statistical analysis are expected. Phase 1 should demonstrate an understanding of the problem. It should then provide the experimental procedure and statistics to be used in defining the minimum requirements. Phase 2 will contain the experiments and analysis. The quantitative requirements for a minimum field of view and a final live flight demonstration of the minimum requirements is expected.

AF89-257. TITLE: Multiple Mode Optical Switches for Fiber Optic Networks

OBJECTIVE: Prototype optical switches, specifications, and test data.

DESCRIPTION: Optical analysis techniques are requiring multiple mode switches in fiber optic networks. Multiple mode switches allow multiple samples for a single analysis and several different techniques to be applied through the same network. Switches must demonstrate improvements in radiation fidelity, reliability, switching speed, and/or alternative paths beyond the current state of the art. Phase 1 will identify current switch designs and their specifications. It will also identify the proposed improvements or alternatives. Phase 2 will produce prototypes and test results to confirm expectations.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Program Management Office. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/PM/SBIR
Attention: Dr. Bud Durand
1400 Wilson Boulevard
Arlington, VA 22209-2308

The proposals will be processed in the Program Management Office and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 47 technical topics to which small business may respond. A brief description of each topic is included below. The topics originated from DARPA technical offices.

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program popularity increased, this became more and more expensive. DARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality. As a result, DARPA may not fund proposals in each and every topic area. Conversely, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior.

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DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

FY 1989 Small Business Innovation Research Topics

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3. Fusion of Information from Synthetic Aperture Radar (SAR), Multi-Spectral Images, and Topographic Data to Detect Ground Disturbances Caused by Large Explosions
4. Investigation of Potential Applications of Neural Network Architecture to Seismic Processing Problems
5. Techniques for Passive Imaging of Spatially-Distributed Radiation Sources
6. Development of Artificial Intelligence (AI) Applications for Automated Review of Documents Created on Word Processors for Compliance with Security Guidelines
7. Unconventional Sensors
8. Applications of Acoustic Charge Transport Devices
9. Lower Echelon Reconnaissance Surveillance and Target Acquisition (RSTA) Systems
10. High Power Active Acoustic Cancellation
11. Hunter/Killer Countermine Systems
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13. Lightweight Sea-Launched Kinetic Energy Anti-Satellite System (ASAT)
14. Basic Research into Metallurgy of Heavy Metals at High Temperature and High Flow Rates
15. Innovative Methods for Reducing Costs of Guided Munitions
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DARPA89-001 <u>Investigation of Knowledge-Based Processing Techniques to Seismic Waveform Analysis</u>

DARPA is interested in novel techniques in which information gained from knowledge of specific features of signal generation or propagation can be utilized in advanced seismic processing systems.

Work is also sought on knowledge-based methods which examine populations of seismic signals and extract features which can be used to enhance the detection, location, and identification of seismic events. A particular need is for applications to high-frequency arrays.

DARPA89-002 <u>Analysis of Multi-Spectral Space Photography to Determine Geological and Geophysical Ground Features</u>

DARPA is interested in development of methods which use multi-spectral space photography (e.g., SPOT, LANDSAT) to identify and characterize rock mineralogy, active and ancient faults, contacts between geological formations, lineaments, etc. Included in these desired studies are methods which can determine physical features of rock types based on their spectral emissivity. Some emphasis is needed on whether or not rock formation have been recently disturbed or not.

In this work sought, interest is on both development of fundamental techniques and on well focused integrated experimental case studies which combine multi-spectral space imagery with ground observations. Integration with existing geological maps should be considered.

DARPA89-003 <u>Fusion of Information from Synthetic Aperature Radar (SAR); Multi-Spectral Images, and Topographic Data to Detect Ground Disturbances by Large Explosions</u>

DARPA is interested in developing technologies which exploit the diversity of information contained in various physical observations of areas near large underground nuclear explosions.

Methods are sought which can detect the effects of an underground nuclear test when observations are made before and after the explosions, and to determine features of the ground disturbances which are indicative of features of the explosion.

DARPA89-004 <u>Investigation of Potential Applications of Neural Network Architecture to Seismic Processing Problems</u>

DARPA is interested in work which investigates neural network architecture and methods to evaluate seismic waveforms for extraction of parameters for seismic event identification. The application is the differentiation between signals from naturally occurring events and those from explosions.

Novel methods for the integration of neural networks with advanced seismic data processing systems and knowledge-based seismic processing systems are desired. Methods for the extraction of parametric information from large volumes of seismic waveform data in order to develop new methods for identifying specific seismic phases are desired.

DARPA89-005 Techniques for Passive Imaging of Spatially-Distributed Radiation Sources

DARPA is interested in exploring possible methods for processing measurements of passive radiation emitted by nuclear sources over a broad spectrum of energies. Measurements include those of neutron and gamma rays. Methods are sought which can sample the radiation flux to determine the spatial extent and variation in intensity as a function of position for unique radiation sources.

DARPA89-006 Development of Artificial Intelligence (AI) Applications for Automated Review of Documents Created on Word Processors for Compliance with Security Guidelines

The DARPA Security Division is interested in developing software for the purpose of"proofreading" documents for proper classification markings. The software shall include the following.

(1) Classification marking criteria in accordance with organization policy and regulation (Executive Order 12356, DoD 5200.1-R, and DoD 5220.22-S-2).

(2) Prompts to suggest missing classification markings where applicable.

DARPA89-007 Unconventional Sensors

Modern military craft generally emphasize a reduction of observable signature (radar, infrared, visible, etc.) to enhance their battlefield survivability. In addition, modern forces can be expected to take full advantage of cover, concealment, and deception techniques. These factors will combine to reduce the effectiveness of conventional military sensor systems in the detection and classification of targets.

In light of such efforts to reduce the effectiveness of conventional systems, DARPA is interested in examining unconventional sensing concepts which, though perhaps less capable, in a general sense posses special characteristics which make them desirable or even required for target detection, tracking, or classification/identification. Such sensors may seek to exploit unusual target signatures which are perhaps unsuppressed, or use a form of energy which is less affected by current conventional techniques. The interest includes specialized sensor concepts that may have been previously discarded but merit reexamination in light of technological advances in signal processing, components, or other underlying technologies.

All military target classes are of interest, including ground based moving and stationary and airborne fixed wing and rotary. Similarly, a wide variety of sensor platforms/configuration are of interest, including ground bases, airborne manned and unmanned, unattended, and active or passive, distributed, netted, or point. Sensor performance requirements should be commensurate with envisioned platform, configuration, and application. For example, detection range from suppressed/hidden targets can be significantly less for an airborne sensor in a cued search than for a standoff surveillance sensor.

DARPA89-008 Applications of Acoustic Charge Transport Devices

Acoustic Charge Transport (ACT) technology has evolved in recent years from a basic research activity to the demonstration of ACT devices which are suitable for application on 6.2 and 6.3 developmental systems. ACT devices are sampled-analog signal processing elements similar in some respects to both charge-coupled devices and surface acoustic wave devices, but without the more serious limitations of either of those older technologies. The devices demonstrated to date or under development include digitally programable transversal filters, fixed and programmable vector processors, correlators, analog memories, convolvers, and various hybrid structures. These devices all offer extremely wide bandwidths and dynamic range, low noise operation, and the advantages of implementation as monolithic Gallium Arsenide integrated circuits. Ultimately, the integration of ACT devices with digital processing elements on the same chip will provide extremely powerful and compact processor structures.

The application areas for ACT devices include radar and radar ECM, electronic support measures, and communications systems. The devices allow for enhanced performance of conventional concepts as well as making possible new, innovative approaches. Proposals which address the exploitation of ACT technology and devices for military systems are of current interest to DARPA. Any novel application concept will be considered, ranging from insertion into existing systems to entirely new system or sub-system concepts made potentially feasible because of ACT. Novel ACT device/processor architectures and their applications are also of interest, including research in fabrication, production and testing of such devices.

DARPA89-009 Lower Echelon Reconnaissance Surveillance and Target Acquisition (RSTA) Systems

There is a need for a surveillance system capable of detecting and locating enemy targets such as fixed installations, command posts, ground vehicles, helicopters and low flying aircraft of concern to the combat force lower echelons such as the brigade level. The brigade commander has few assets to observe the area and range of his responsibilities and must rely on data from upper echelon sensors which may not provide information in sufficient time to appropriately react.

Typically, range coverage required for the brigade surveillance system would be from the Forward Line of Troops (FLOT) to about 30 Km beyond the FLOT. The ground targets may be on roads or in assembly areas and may be obscured to a ground level observer by terrain. Enemy helicopters flying nap-of-the-earth may also be similarly blocked by terrain.

The goal of this research program is to assess new and novel concepts for the surveillance and target acquisition system functioning at the brigade level. The following topics are subsets of the overall system capabilities that may be studied as a separate task or in combination:

(1) The sensor or combination of sensors must detect and locate targets with a high probability of detection while keeping the false alarm rate low. The sensors must perform in all weather and battlefield environments.

(2) An assessment of the trade-offs involved in deploying the sensors at ground level, on quick erectable masts or on an unmanned aerial vehicle (UAV).

(3) Concepts for low-cost, easily and quickly launched and simply recoverable UVA platforms capable of deploying surveillance sensors.

(4) Methods and concepts for providing the surveillance data gathered by the sensors in near-real time to a central information processing station in which the data is assimilated to display forces or target data so as to provide situation assessment, targeting and weapons assignment functions.

DARPA89-010 High Power Active Acoustic Cancellation

Detection or cueing due to acoustic emissions is an area of concern for numerous land combat systems and missions. These include artillery, tracked vehicles, helicopters, and various special operations equipment. Analysis and development is desired of systems capable of generating cancellation signals in real time and coupling these to high power, responsive sound generation systems capable of canceling or minimizing the acoustic emissions of the above systems. Analysis should include considerations of affordability, size and weight, and operational suitability of the objective system.

DARPA89-011 Hunter/Killer Countermine Systems

Research and development is desired for systems capable of both detecting and destroying land mines. These systems will typically have two modes of operation: a "hunter" mode which uses relatively modest amounts of power and achieves a high rate of forward movement, and a "killer" mode in which maximum energy is focused on suspected mine detections, and which results in a certain kill if a mine is present. A capability against all types of mines is desired; these include metallic/non-metallic and buried/surface-land. Analysis should also include consideration of affordability, size and weight, and operational suitability of the objective system.

DARPA89-012 High Velocity Antitank Rocket Having a Very Low Minimum Effective Range

Current high velocity antiarmor rockets require a relatively long range and time of flight to reach effective velocity. This condition renders such weapons ineffective at close range and provides the target with critical reaction/response time at longer ranges. It is desirable to develop a high velocity rocket boosted munition which could be tube or recoilless rifle launched, accelerate to effective velocity within a very short range (300M), and be effective against modern tank armors.

DARPA89-013 Lightweight Sea-Launched Kinetic Energy Anti-Satellite System (ASAT)

DARPA and the U.S. Navy are interested in combining their lightweight KEW type warheads with advanced sea-based launcher concepts to develop an affordable system for countering satellite threats to naval task forces. The rapid advances made recently in miniaturization in the various fields of computers, GPS position/velocity determination, maneuvering propulsion units, seekers and sensors, make lightweight low-cost mobile sea-based ASATs feasible. Sea-based mobility allows the launch of smart ASAT weapons against low-altitude high threat enemy ocean surveillance systems which form a key element in targeting naval forces. Additional intercept capability is possible against satellites of the Molniya type orbits launched at or near their perigee points. First orbit capability is obtainable with sea launch assets not involving aircraft, located at or near the apsidal points of key Soviet space launch complexes. These points are located in the South Pacific. Innovative concepts for the combining components, technologies and innovative logistics to address this requirement are needed.

DARPA89-014 Basic Research into Metallurgy of Heavy Metals at High Temperature and High Flow Rates

Research into the metallurgy of Depleted Uranium, Tantalum and other heavy metals as experienced during warhead detonation. An illustration of the problem is the variability in penetration performance (Factors up to 2) of developmental heavy metal liner warheads (Shaped charges in EFPs).

DARPA89-015 Innovative Methods for Reducing Costs of Guided Munitions

Recent advances in focal plane arrays and strapdown guidance can result in advantageous missile designs where both the seeker and the inertial measurement unit (IMU) are hard mounted to the missile body. However, these designs are susceptible to vibrations induced by engine firings or aerodynamic noise. The seeker can experience jitter and hence image smear. Potential payoffs for strapdown guidance include major reductions in cost, weight and mechanical complexity. Innovative concepts and design approaches are needed for small missiles and terminally guided submunitions (TGSM's).

DARPA89-016 <u>Innovative Applications of New Lightweight/Low Cost Inertial Measurement Unit (IMU) Technology for Precision Guided Munitions</u>

In the past several years, new candidates have emerged for lightweight and low cost inertial measurement units (IMUs). Technologies such as fiber optics, vibrating quartz, tuning forks, and other have been successfully employed for sensing both angular rate and lateral acceleration. Also, advances in custom electronics have enabled packaging complex navigation processing in a small weight and volume. DARPA is interested in potential applications of these emerging IMUs for small guided projectiles. For example, can the addition of an IMU improve the accuracy of a tank or howitzer round such that cost per kill is significantly reduced. Also, how can an IMU be integrated into currently fielded rounds. Other issues include dealing with a high "G" launch environment and post launch alignment.

DARPA89-017 <u>Relocatable Target Detection and Targeting Technology</u>

The Defense Advanced Research Projects Agency is investigating the technology for detecting and targeting strategic targets which are capable of relocating on a frequent basis. Examples of this category of target are rail-mobile and road-mobile intercontinental ballistic missiles. Because of the location uncertainty, targeting acquisition systems are required which are often based on imaging sensors that rely on distinguishing the target from the background using visible, infrared or radar portions of the spectrum. However, detection capability is degraded if the target is located in a heavily cluttered environment and employs active deception and denial techniques (e.g., camouflage).

If the target location is uncertain or has changed before commit of a weapon, automatic target cueing/recognition techniques may be required to handle the large number of images generated during the search to reacquire the target. Possible approaches may take advantage of other regions of the electromagnetic spectrum, of unique signature phenomenology of man-made versus natural objects, of innovative sensor combinations, or of innovative sensor processing technology. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally useful. It is anticipated that the investigation of these technologies would be divided into two phases:

(1) Concept definition and analysis. The concept definition will include the operational architecture and emphasize how the innovative approach will contribute to improved effectiveness. The analysis will include theoretical development based on physical principles as well as an analytical assessment of available experimental data.

(2) Demonstration. Based upon successful conceptual analysis, a laboratory demonstration will be developed to verify the technical approach.

DARPA89-018 Intuitive Cockpit Displays for Fighter Aircraft

DARPA is interested in innovative concepts to increase the effective bandwidth by which information is communicated between on-board computers and fighter pilots. The symbology of current cockpit systems has evolved from mechanical instruments. In a quite separate environment, the man/machine interface for personal computers has evolved along a separate path, unhindered by a mechanical predecessor. The result has been a significant growth in the ability of the user to comprehend the machine's recommendations.

Based on historical trends, the information processing capability that will be installed in future fighter aircraft is likely to increase by one to two orders of magnitude per decade. The ability to communicate the conclusions of the on-board machine intelligence to the human operator are limited by the effective display bandwidth. Without some new display concepts, it is questionable whether future systems can expand the capability of the pilot to interpret and use the information that the machine can make available.

DARPA89-019 Superconducting Focal Planes

DARPA is interested in technology implementing high temperature superconductors in focal planes. Wavelengths of primary interest are in the long wavelength infrared, but there is also interest in both shorter (towards visible) and longer (towards millimeter wave) wavelengths. The demonstration of new detector phenomena is of interest, but the long term goal is to produce an all superconducting focal plane. The demonstration of pre-processor electronics, such as analog to digital converters, multiplexers, and the interface between these elements and the detector is of interest.

DARPA89-020 Remotely Piloted Vehicle (RPV) Technology

In recent years services have desired to field Remotely Piloted Vehicles (RPVs) which are highly reliable, provide increased utility and are cost effective. This situation has placed greater emphasis on achieving combinations of higher altitude, longer endurance, greater payload capacity, higher reliability and increased survivability. To achieve these more efficient/cost effective systems it is necessary to exploit various technology areas and extend the state-of-art. New and innovative approaches proposed should provide technology development which will yield more capable systems to fulfill the future needs of the Master Plan.

DARPA89-021 Application of New Materials for Lighter-Than-Air Vehicles (Balloons, Airships, and Hybrids)

The Defense Advanced Research Projects Agency(DARPA) is interested in developing materials technology required to support Lighter-than-Air (LTA) systems. Technologies to be pursued must be shown to have demonstrably better first order characteristics than materials used with existing LTA systems. First order characteristics of interest include, but are not limited to, weight, strength, UV-resistance, and helium permeability.

The scope of this effort will be to take new, but existing, high performance materials and develop and evaluate their applicability to real LTA systems. Areas of special interest include: bonding technology, handling characteristics, pin hole and crease resistance. This effort does not include efforts to make new and hitherto un-tested materials.

It is anticipated that in the first phase of this effort the state of the art in materials technology will be extended to a point that a small, but real, LTA structure can be designed and built. For example, specific bonding techniques which will enable small LTA structures to be fabricated might be developed or tested, and requisite designs will be developed for a small LTA test vehicle. In Phase 2 of the effort it is anticipated that a small LTA structure will be built and tested to demonstrate the advantages of the particular material system under consideration.

DARPA89-022 Low Observable Technology For Infrared Suppression on Aircraft

A technology base is required that will allow the suppression of infrared signatures that contribute to aircraft detection or missile guidance against aircraft. Techniques to cool propulsion systems or airframe parts, inherently cool propulsion systems, materials and coatings with reduced propulsion systems, materials and coatings with reduced emissivity or which can deflect aircraft radiance, or techniques to modify plume signatures are all of interest. Also, infrared control techniques and materials which can synergistically support radar and/or optical control signature control requirements are of interest.

DARPA89-023 Radar Cross-Section Reduction Techniques Applicable to In-Band Antenna Scattering

The Defense Advanced Research Projects Agency is interested in pursuing new and innovative techniques which could be used to reduce the radar cross-section of antennas within the frequency band that they function in. Major measures of merit for any technique to be pursued will be the degree to which the proposed cross-section reduction technique reduces the performance of the antenna in its role as an effective radiating and receiving structure and the cross-section reduction that can be obtained. It is envisaged that the first phase of this effort will include a detailed analyses of any proposed technique and a design for a test system that could be built to verify the analyses. Phase 2 of this effort would include the building and test of an antenna system which would demonstrate the cross-section reduction technique and the impact of the technique on the basic performance of the antenna system. Also, the Phase 2 tests should validate the analyses that was undertaken in Phase 1.

DARPA89-024 Moving-Target Detection and Tracking Technology

The Defense Advanced Research Projects Agency is investigating new approaches to detecting and tracking strategic aircraft in background clutter. Current target acquisition and tracking systems often assume radar and optical/infrared sensors will be interrogating prospective vehicles at an initial single-look

signal-to-noise ratio (SNR) between 2 and 7 dB. New vehicle technologies indicate future single-look SNR will be below 0 dB.

DARPA is interested in innovative techniques for detecting and tracking these strategic aircraft. Possible solutions may take advantage of innovative track-before-detect procedures, novel moving-target-indication strategies, innovative sensor combinations, new data fusion algorithms, or other innovative sensor/signal processing technology. Strong emphasis will be placed on truly innovative concepts that offer the potential for real SNR improvement on the order of 20 dB or more, even if there is technological risk involved. Proposals should include a discussion of how the proposed technology would be operationally useful. It is anticipated that the investigation of these technologies would be divided into two phases:

(1) Concept definition and analysis. The analysis will include theoretical development based on physical principals as well as an analytical assessment of experimental data.

(2) Based upon successful conceptual analysis, a field demonstration/experiment will be developed to verify the technical approach.

DARPA89-025 <u>Tools for Precision Machining of Brittle Materials</u>

DARPA is interested in exploratory development of tools to facilitate extremely high precision machining of brittle materials, especially glasses but also ceramics. Tools should be capable of removing materials to a surface figure accuracy on the order of 100 nanometers rms, with precision on the order of 10 nanometers, when interfaced with a machine capable of presenting the tool with compatible levels of accuracy and precision. The tool should be capable of operating on a large range of materials relatively independent of their chemical composition. Optical glasses are a prime application. Tools should be such as to leave no subsurface damage, with surface finish accuracies not worse than 30 Angstroms rms. The tools should not affect the bulk chemical composition of the material being machined. Any material removal mechanism, cutting, grinding, ablation, etch, etc., will be considered providing it has the capabilities required. Tools should be capable of surfacing work pieces up to 15 cm in diameter without unacceptable tool wear.
The ultimate role of the tool is to facilitate fully automated, high rate production, so tools which have the potential for high material removal rates and which require minimal alignment, upkeep, and operator attention will be considered most favorably.

DARPA89-026 <u>Material Structures for 3-Dimensional Non-Volatile Mass Storage</u>

Requirements for non-volatile memory span a broad range from data-intensive parallel processing applications to space-based signal-processor needs for fast-access, low-power survivable memory. DARPA is interested in exploring new materials and structures to implement non-volatile memory. Two specific areas of interest are:

(1) Applications of optics to the realization of high-density non-volatile mass storage systems capable of reading and writing data in twodimensional formats. Desirable characteristics are: density greater than 100 gigabits/cubic inch, read speed less than 10 microseconds, write speed less than 100 microseconds, and nondestructive readout of stored data. One envisioned application would be to provide two-dimensional data fields to two-dimensional spatial light modulators for optical computing. Current research needs are in the areas of materials for three-dimensional optical storage and holographics for beam shaping. The storage media need not be homogeneous, but rather may consist of a layered structure; i.e., a buffered stack of twodimensional storage planes.

(2) Novel ferroelectric thin-film materials compatible with semiconductor materials for non-volatile random-access memory (NVRAM) applications. Research goals are for new ferroelectrics that can meet the following needs in memory storage: transition temperature above 200^{o}C; processing technology that minimizes defects and is compatible with Gallium Arsenide (GaAs) circuit processing; radiation hardness; read and write access times/polarization switching time less than 10 ns; coercive voltage less than 2 V; polarization retention for years; endurance of more than 10^{15} read/write cycles; and adequate DC breakdown.

DARPA88-027 Soft Kill of Fielded Weapon Systems

DARPA is interested in developing methods for attacking the "soft" components of offensive weapon systems, particularly armored land vehicles, and render them incapable of action in the battlefield. "Soft Kill" in this sense is an abort of mission which is not due to a catastrophic kill of man or machinery, but rather is caused by a critical subsystem failure. It is a specific attack on vulnerable subsystems, and avoidance of attacking the hardened portions of the target. Methods employing directed energy weapons (lasers, microwaves) are excluded from consideration, though other anti-sensor techniques are acceptable. Novel concepts are solicited for developmental support. Some attendant considerations are:

(1) No new delivery system should be required; the description should identify what modifications are necessary within current systems for implementing the concept.

(2) Means of identifying such a non-catastrophic kill should be discussed.

(3) Delay times, or dwell times to onset of subsystem affects and possible recovery of function should be stated.

DARPA89-028 Testing and Packaging Technology for Multi-Gigahertz Bandwidth, High Pinout Density Digital Circuits

Available testing and packaging capabilities limit the evaluation and utilization of Gallium Arsenide (GaAs) digital integrated circuit (IC)

technologies. DARPA is interested in techniques to address these testing and packaging needs for multi-gigahertz-bandwidth ICs with high pinout density. Proposals should address one or both of the following areas:

(1) High-speed testing methods for large-1/O-count ICs, including in-process testing, wafer-probe testing, and/or packaged-part testing.

(2) High-speed packaging techniques for large-I/O-count ICs.

Proposals should address needs of current and next-generation state-of-the-art GaAs circuits and systems. DARPA encourages offerors to include high-speed modeling and simulation, considerations of costs and benefits of the proposed approach(es), and plans for marketing and implementing the proposed technique(s).

DARPA89-029 Device Applications of Self-Assembling Microstructure

Interest in self-assembling materials (SAM's) is driven by the possibility of doing "bottoms-up" fabrication of materials from the molecular level, and by a need for simple manufacturing and processing technologies appropriate to the production of complex, durable structures.

Recent work has demonstrated the ability to form hollow, polymerizable soda-straw like structures whose nominal diameter is 0.5 microns and whose length can be made to vary from 10 microns to greater than 2 mm. Intrinsic particle properties include: 1) anisotrophy, helicity and chirality on the micron scale -- which provides a basis for control of particle orientation and optical/electronic interactions, 2) quasi-cylindrical symmetry with a hollow core -- which offers rigidity, porosity, low mass and non-linear optical interactions, 3) controlled aspect ratio -- which provided for tailored, broad-bank electromagnetic interaction/resonances; diffusion-limited separations; flow modification and fiber-like behavior, 4) internal/external surfaces and edges -- offering a foundation for novel catalysis and surface controlled chemistry, 5) microvial capability -- for encapsulation and ceramic microengineering, 6) microhoneycomb structure -- for the fabrication of high strength to mass materials 7) confined axial growth -- which might be exploited in the formation of controlled assymetric interconnects and 8) bottoms-up fabrication -- which allows rational control of bulk, film and surface material properties. The particles may be exploited either directly, because of their intrinsic properties, or as substrates or templates of unique size and morphology for subsequent fabrication/processing steps (eg. as in the formation of particle-based whisker reinforced composites). The particles have been successfully coated with a variety of thin metallic films, aligned in both aqueous and non-aqueous media and embedded with controlled alignment in both epoxies and optical cements.

Diverse applications have been identified including their possible use in high purity/high throughput separation systems, as dual-use low observable materials, as high dielectric materials for energy storage devices, as conducting composites for RF shielding, as component elements in advanced acoustic sensors and in non-linear thin film optical devices. Interest exists in proposals seeking to exploit these materials in device application.

DARPA89-030 Supercritical Fluid Technology for Retired Weapon Deactivation

Supercritical Fluid (SCF) technology offers the opportunity to effect efficient, economical, and safe demilitarization of obsolete chemical weapons and explosive munitions and propellants. Key issues include determining appropriate supercritical fluids and temperature and pressure conditions suitable for reducing chemical agents to relatively non-toxic materials and determining SCF systems that are suitable for demilitarizing propellants and explosives so that the energetic components can be recovered.

Proposed programs should address either 1) investigation of reactions of organo-heteroatom compounds such as chlorinated organics and organophosphorus compounds in SCF fluids that are relevant to the development of a closed SCF reactor for destruction of chemical agents, or 2) investigation of reactions of energetic materials such as nitramines in SCF and the separation of energetic materials components using SCF technology. Proposers should describe specific systems to be investigated, approach, and products expected following SCF processing.

DARPA89-031 Techniques and Design for Wide-Band Correlation of Digital or Analog Data Streams

The correlation of two or more data streams -- whether digital or analog -- is a vital function of most DoD electronic systems. Correlation finds application, for example, in communications, radar and sonar systems. The increasing complexity of the operating environment for military electronic systems results in the need for these systems to correlate very large -- on the order of one million points -- data and signal streams. Present fielded technology presents a problem in that it does not support wideband correlation of signals that cannot be detected by conventional superheterodyne receivers in near real-time. Therefore, this solicitation is for research leading to analytical techniques, algorithms and designs for near real-time correlation of analog and digital signal/data streams which may not be detectable by conventional receivers. The correlation size to be addressed is a minimum of 1,048,576 points in each of two streams. Emphasis shall be placed on proposed research to utilize new signal processing technology to include: Acoustic Charge Transport Devices (ACTs), Surface Acoustic Wave Devices (SAWs), Optical Bragg Cells, Magnetostatic Wave Devices (MSWs) and Digital Correlators. The deliverable products of this research will be algorithms and implementation architectures for wideband correlation using these (and similar) devices. Analytical techniques to be applied shall include (but not be limited to) Finite Fourier Transform Methods, Algebraic Ring Theoretic Methods, Source Code Approximation Methods, Cyclotomic Polynomial Methods and Galois Field Theoretic Methods.

DARPA89-032 Improving Mechanical Strength and Toughness of High Temperature (greater than >90^{O}K) Bulk Ceramic Superconductors

Improvement in critical current density values in bulk ceramic superconductors has occurred over the last years however, very little improvement has been obtained in mechanical strength. For large scale applications such as magnets and electrical machinery, high strength materials are needed to contain the

high magnetic fields that can be generated with these new ceramic superconductors. These materials must have tensile strengths comparable to high strength stainless steel or greater and be chemically stable in liquid nitrogen. Novel ideas are expected to include multicomponent composite materials with the superconductor to increase the overall strength of the component (wires, tapes, monoliths, etc.). Multicomponent materials may include polymers, metals or other ceramic materials with processes such as electrodeposition and other coating approaches. Proposals are expected to set goals in strength, critical current densities, and chemical stability. Characterization techniques and facilitates should also be described.

DARPA89-033 Fabrication and Processing of Non-Graphite Fibers Compatible with Ceramic and Intermetallic Matrices

High temperature ceramic matrix and intermetallic compound (e.g. Ti-Al, Nb-Al) matrix composites show excellent promise for some aerospace structural applications. Ceramic fibers and/or whiskers offer a potent means of strengthening and toughening such composites. There are commercial or semi-commercial fibers of alumina, silicon carbide, silicon nitride, aluminosilicates etc. This solicitation seeks novel processing routes to prepare monofilament and/or multifilament ceramic fibers or ceramic whiskers of the above materials as well as boron nitride, titanium diboride, zirconia or other ceramics. A rationale for the choice of fiber and processing techniques should be presented. Proposers should state goals of strength, modulus, temperature stability, appropriate electrical properties, and an assessment of the economics of producing the fibers/whiskers in commercial quantities.

DARPA89-034 Assessment of Countermeasure Materials by Combat Modeling

The development of a variety of countermeasures techniques, dependent upon the application of advanced materials and structures, could be aided by their assessment within battlefield models which gauge overall efficacy within a realistic context. Examples of such countermeasures are (1) sensor protection against directed energy weapons, (2) signature reduction within the microwave and infrared regimes, (3) enhanced armor to resist modern penetrators, and (4) CBW protection. Each has limitations in its protective ability, and each confers some performance degradation upon the system. It would be of interest to measure the effectiveness of such countermeasures, and others, within an acceptable battlefield model and perform sensitivity analysis of the basic materials and structures supporting the countermeasure. Concepts are solicited for modifying a standard battlefield model to allow convenient manipulation of material and structural parameters for the optimization of countermeasure techniques.

DARPA89-035 Precursors for Organometallic Chemical Vapor Deposition of Compound Semiconductors

DARPA is interested in methods for improving the quality and reproducibility of organic precursor gases for use in compound semiconductor organometallic chemical vapor deposition (OMCVD). While OMCVD offers a powerful production-oriented growth technique for advanced electronic and optoelectronic devices,

it has traditionally been hampered by the lack of consistent high-purity gas precursors. This problem exists for a broad range of precursor materials for OMCVD of gallium arsenide, indium phosphide, cadmium telluride, and their related alloys.

In this program, our goal is to develop techniques to improve significantly the purity and batch-to-batch reproducibility of key OMCVD precursors. Proposals should include an assessment of (or a plan to assess) criticality of purity and reproducibility for the various precursors, including data that relates materials quality to device performance; a description of the proposed technique(s) for addressing the problems; a test and evaluation plan to measure the improvement in terms of materials and device characteristics; and a roadmap for implementing the improvement technique(s) in precursor production or OMCVD growth systems, as appropriate.

DARPA89-036 Reconstruction and Enhancement of Signal (Including Images, Acoustics)

DoD has the problem of computer-based reconstruction and enhancement of transmitted data and other signals. There is the need for noise removal, deblurring of smoothed images and the accurate and sharp reconstruction of edges in transmitted images. Applications include removal of noise in radar and sonar signals, computer enhancement of images and storage of decaying archival photographs. Techniques applied to this problem in the past involve global smoothing, via the Fourier transform and/or statistical techniques, global deconvolution and edge detection. These techniques introduce edge smearing due to the global noise removal and "ringing" (oscillations resembling the Gibb's phenomena) which causes "ghosts" or "echoes". Such edge smearing makes accurate edge detection very difficult. To resolve the difficulties presented by existing technology, DoD seeks new methods for computer-based reconstruction and enhancement of signals. The techniques and methods must be local and nonlinear, and emphasize the processing and reconstruction of singularities in the signals. The methods and techniques must be capable of handling:

(1) Large -- 10 to 1 -- noise to signal ratios;
(2) Extensive blurring -- 1 to 1 blurring to signal ratios; and

(3) Multiple scales -- 1000 to 1 ratios.

The application of recent analytic and numerical techniques and results concerning singular solutions to problems involving shocks and turbulence should be incorporated. The deliverable products of this research will be algorithms and methods for signal enhancement and reconstruction with the above stated capabilities.

DARPA89-037 Coating for Fibers and Particulates in High Temperature Composites

With the increasing use of structural metal matrix and ceramic matrix composites at high temperatures it has become apparent that coatings are needed on reinforcing fibers for a variety of reasons: to provide weak interfaces in

brittle matrix composites, to provide barriers to elevated temperature chemical reaction between fiber and matrix during processing subsequent use, and to tailor the electrical properties for some composites. Fiber coatings will depend on the matrix and the use temperatures. Proposers should justify the choice of fibers and coatings systems. Matrix systems of interest include ceramics, titanium alloys and titanium aluminides. Proposed programs should address the thin uniform coating of multifilament tows of ceramic and/or graphite fibers at economically attractive rates. Processes can include but are not limited to chemical vapor deposition (CVD) and plasma activated CVD, ion plating and processes based on sol gel and preceramic ploymers. Coating materials of interest include a variety of refractory oxides, carbides, nitrides, borides and metals. Innovative processing approaches are encouraged, especially those that have the potential to increase deposition kinetics and improve coating economics.

DARPA89-038 Applications of Case-Based Reasoning (CBR)

This SBIR seeks proposals to explore the advantages and disadvantages of building AI applications developed using the "case-based reasoning" paradigm. Needed are insightful approaches to prototyping decision support systems in domains which seem resistant to applications based on other AI paradigms; tests of these applications to verify the performance or developmental advantages of case-based reasoning; and identification of possible research directions needed to improve CBR technology.

Potential bidders need to establish their technical credibility in case-based reasoning; provide some indication of the software tools that would be used to prototype the application in Phase 1 (i.e., why the tools simplify CBR unique requirements); and rationale for applying CBR to the selected problem.

DARPA89-039 Development of Image Understanding (IU) Environments

This SBIR requests the development of a prototype IU Environment. Needed are innovative approaches to improve prototyping of computer vision systems combined with a proven capability to maximize programmer productivity for research and development activity in image understanding. It is envisioned that fully acceptable copies of a prototype IU environment derived from this SBIR could be used for further development, facilitating technology exchange within the DARPA IU community, and accelerate IU technology transfer to the broader U.S. community via later testing and enhancement. Potential bidders need to establish their technical credibility in both image understanding technology and software development environments.

Some of the specifications expected of an envisioned IU Environment:

(1) Support a wide range of vision processing an integrated manner; specifically, this should include support for low-level image processing (i.e., pixel and local neighborhood operations), intermediate symbolic processing (e.g., token manipulation operations), and high level tasks (e.g., blackboard communication and control among tasks).

(2) Have a flexible and state-of-the-art graphic user interface.

(3) Be an extensible system so user or imported software can be easily integrated to rapidly prototype applications composed of separate IU modules.

(4) Support a highly effective data examination of the results at any level of processing; specifically, it should support graphic presentation of results of pixel processing and token processing on images.

(5) Support multi-tasking applications (possible processed concurrently). Run on a common class of workstations that support C and Common LISP programming languages as a minimum.

DARPA89-040 Underwater Communications

Underwater communications is the key bottleneck in organizing the efficient utilization of the submarine force. New methods and concepts are sought for implementing communications between submarines and surface ships/submarines. The ideal method would provide high bandwidth, high speed communications over relatively large geographic distances. Methods that minimize the loss of data and attenuation of the signal are especially attractive. Acoustic techniques (including far-field propagation) and guided electromagnetic propagation (including fiber optic cable networks) are especially sought. New concepts must take into account reliability and connectivity constraints, security procedures (to prevent localization upon detection), and survivability in times of crisis.

DARPA89-041 Low Cost Hydrophone Technology

New concepts and methods are sought for developing low cost hydrophone networks including technologies for wet side and dry side acquisition and processing. These concepts include signal amplification and processing techniques (including efficient digitization and multiplexing methods), new materials for hydrophone development which can operate at different center frequencies, tunable hydrophones, and system architectures for organizing large hydrophone networks (> 10000 elements) for real-time processing. Application of advanced computer technology such as parallel processing, artificial intelligence, and high speed ASICs are also sought.

DARPA89-042 Optical Characteristics of the Ocean

Methods are sought to conduct rapid, economical surveys of large ocean areas to determine optical transmission properties in the upper few hundred meters, and variations in these properties over horizontal scales of tens of miles. The ideal method would measure absorption and scattering through the visible band. (Minimal information would be diffuse and beam attenuation coefficients.) Ideally, the collection instrument could be carried in satellites, but remote sensors or expendable profiling sensors that can be deployed from aircraft

would also be of interest. Use of existing or planned remote sensors by way of novel analysis methods would be especially attractive.

DARPA89-043 High Speed Merchant Ship Concepts

A critical issue is the survivability of the merchant ship fleet in time of war (as evidenced by the lessons learned in WW II). New concepts are sought for improving the design and architecture of surface ships for speed, capacity, detectability, and survivability in the event of conventional warfare. Concepts focusing on submarine cargo carriers are also sought. New propulsion techniques and hull designs (including hydrofoils) that can produce speeds in excess of 40 knots are especially desirable. New methods for analyzing interception tactics and countermeasures during conventional warfare to prevent interdiction of merchant ship traffic by the submarine force are also sought (including new simulation and analysis capabilities).

DARPA89-044 Radar Ocean Imaging

Methods are sought for high resolution imaging of phenomena resulting from modulation of subsurface internal waves. These methods include signal processing techniques for synthetic aperture radar; novel measurement techniques (including possible experiments); parameter extraction, pattern recognition, and data processing techniques, and concepts for system architectures for SAR systems (including integration with other C^3I systems). New instrumentation concepts, especially those involving ASIC technology and on-board intelligent processing are also sought. Use of existing or planned sensors in definitive experiments would be especially attractive.

DARPA89-045 Wavelength Conversion Techniques for Mid-Infrared Laser Sources

Innovative ideas are needed for lasers operating in the mid-infrared spectrum as possible active countermeasures against advanced, infrared seeking missiles. The desired features are to achieve simultaneously multi-spectral output (to match to the bands of the multi-spectral seeker) with sufficient average power and pulsed waveform (to defeat seeker tracker logic and simple countermeasures) at high laser output efficiency. The potential performance of novel laser concepts should be compared to that obtained using existing, efficient high average power laser such as the electrically excited CO_2 laser, DF/HF laser and/or Ga:Al:As semiconductor laser and appropriate wavelength conversion techniques. The tasks in Phase I are to analyze the various approaches, and identify the most promising path for experimental verification in Phase II.

DARPA89-046 Anti-Jam Electronic Processing Techniques for Protection Against CW and Pulsed Lasers

Innovative ideas are needed for high performance sensors, which retain their high performance in the presence of CW and pulsed lasers. The potential threat lasers have sufficient power to jam but not damage the sensor. The sensors of interest operate in the visible to the near infrared, and could include TV sensors and focal plane sensors. The tasks in Phase I are: (1) to analyze the

various approaches including the use of electronic processing, low scatter optics and tunable optical filters to provide a high performance, anti-jam sensor and (2) to design an economical, anti-jam, high performance sensor concept that will be built and tested in Phase II.

DARPA89-047 Novel Methods for Protection of Personnel Against Lasers

Innovative ideas are needed for protecting eyes of personnel against potential battlefield lasers which are wavelength diverse or wavelength agile. The novel methods should be able to protect against lasers which might have nanosecond rise times. These methods should provide optical density of three to four at the wavelengths of commercial and laboratory lasers, which could be scaled efficiently and compactly to medium average output powers. Such lasers might include frequency doubled Nd:YAG, Excimer, Argon ion, Copper Vapor, dye, Ga:Al:As, Alexandrite and Ti:Al_2O_3 lasers as well as their Raman shifted outputs. At the same tlme, the total transmission in the visible spectral region for these concepts should be greater than 10% and should maintain color discrimination capabilities for target identification. The tasks in Phase I are to analyze the various approaches and identify the most promising path for experimental verification in Phase II leading to economic production.

SUBMITTING PROPOSALS ON DEFENSE NUCLEAR AGENCY TOPICS

The Defense Nuclear Agency is seeking Small Business firms with a strong research and development capability and experience in nuclear weapons effects and nuclear weapons phenomenology areas. Proposals should be submitted to:

Headquarters
Defense Nuclear Agency
Attn: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

Questions concerning the research topics should be submitted to :

Sandra Young
(202) 325-1078

The research categories proposed for study under this program are:

1. Nuclear Weapons Effects Calculation.
2. Response of Materials to Nuclear Weapon Effects.
3. Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications.
4. Nuclear Weapon Effects Simulation.
5. Instrumentation.
6. Directed Energy Effects.
7. Nuclear Hardening and Survivability.
8. Security of Nuclear Weapons.
9. Theater Nuclear Forces (TNF) Survivabiity.
10. Operational Planning and Targeting.
11. Underground Nuclear Testing.
12. Verification Technology Development.
13. Nuclear Weapon Effects on Propagation.
14. Tactical Application of Pulsed Power technology.

These topics are further explained below. Additional information beyond that provided herein may be obtained by request from the address given above.

DNA-001. TITLE: Nuclear Weapon Effects Calculation
DESCRIPTION: The accurate calculation of nuclear weapon effects is a major concern of DNA. Areas of interest include more accurate calculations, faster running calculations, and microcomputer versions to enable use by a wide audience. Nuclear weapon effects include air blast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and X-ray radiation; electromagnetic pulse; fallout; blueout; blackout; red-out; dust cloud formation; and radiation effects on personnel.

DNA-002. TITLE: Response of Materials to Nuclear Weapon Effects
DESCRIPTION: Of interest is the response of materials, structures, and systems to nuclear weapon effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. The response of underground structures such as missile silos, command and control facilities and communications facilities are especially important. Concepts and techniques which will improve the survivability (decrease the response) of these types of systems to nuclear weapons effects are required.

DNA-003. TITLE: Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications.
DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation and neutral particle beams on electronics, electronic systems, opto-electrical devices and sensors in the phenomenology areas of a) Transient Radiation Effects on Electronics (TREE); b) Electromagnetic Pulse (EMP); and c) System Generated EMP (SGEMP) are of interest to DNA. Particular areas of concern include: methods by which designers of space, strategic and tactical systems can assess their susceptibility to TREE, EMP, and SGEMP; d) hardening technology to reduce proven susceptibilities of electronic devices (especially those with submicron feature sizes) and systems to acceptable levels; and hardness assurance methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects and neutral particle beam are required.

DNA-004. TITLE: Nuclear Weapon Effects Simulation
DESCRIPTION: International treaties preclude the testing of nuclear weapons in the atmosphere and hence it is not possible to test military systems in an actual nuclear environment. To compensate for this, other testing methods are used to simulate the effects of the nuclear detonation. Nuclear weapons effects simulation includes: high explosive testing to simulate the mechanical effects, EMP simulation, thermal radiation simulation, and nuclear radiation simulation. Simulation techniques should be as realistic as possible, relatively inexpensive to perform and comparable to the threat environment. One should become familiar with existing programs to see how they can be improved and/or combined in order to make the total process more realistic and more representative of the actual nuclear weapons effect being studied. Both destructive and non-destructive test methods are desired.

DNA-005. TITLE: Instrumentation
DESCRIPTION: Instrumentation is used for measuring nuclear weapons effects, phenomenology parameters and the response of test items exposed to real or simulated nuclear weapon effects produced by underground testing or in an above ground simulator or in a water shock test. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in underground nuclear tests, high explosive tests, or tests involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should survive long enough to record the needed data and include recording, data transmission and data analysis capabilities. Innovative concepts are required for new instrumentation such as gauges that will survive in environments so severe that existing gauges fail or perform inadequately. Calibration facilities are needed to calibrate existing gauges in every environment where the gauge could likely be used.

DNA-006. TITLE: Directed Energy Effects
DESCRIPTION: The effects of directed energy sources on materials, structures and systems are of interest to DNA. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and mechanisms by which the directed energy sources actually interact with target materials/structures.

DNA-007. TITLE: Nuclear Hardening and Survivability
DESCRIPTION: Techniques for nuclear hardening and survivability of systems/structures against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal and nuclear radiation in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required. Systems include planned and operational strategic and tactical ground mobile systems, missiles, aircraft, spacecraft and their subsystems and components.

DNA-008. TITLE: Security of Nuclear Weapons
DESCRIPTION: Measures to improve the security of nuclear weapons against all possible threats are required. This includes the design of security features both for the actual weapon and for the facilities in which weapons are either stored or transported. These security measures should protect against all known or predicted threats and should be done in such a way as to avoid making the protected item visible as a target. Also of interest are methods to ensure effectiveness and efficiency of nuclear weapon security programs.

DNA-009. TITLE: Theater Nuclear Forces (TNF) Survivability
DESCRIPTION: The prelaunch survivability (PLS) of the TNF is of vital concern. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats to the TNF include enemy forces conducting unconventional,

conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, theater nuclear force movements, and operational survivability of theater nuclear systems (aircraft, missiles, and cannon systems). Survivability concepts are warranted for the period of the 1990's and beyond. Concepts should employ innovative ideas and make use of new and emerging technologies.

DNA-010. TITLE: Operational Planning and Targeting
DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes.

DNA-011. TITLE: Underground Nuclear Testing
DESCRIPTION: Underground nuclear effects tests are used in situations for which no suitable above ground simulator exists. Areas of interest include improvements in the design and execution of tests (horizontal/vertical line of sight and cavity), the design of new experiments which extend the capability of current test beds, innovative test concepts to meet future needs, improvements to the mathematical methods used to perform various calculations within the test design and analysis program, new methods of characterizing existing materials which are used in critical portions of the test bed (such as the A box) and new materials for such applications, new approaches to the geological problems encountered in the construction of the test beds and new methods for all test activities (excavation, fabrication, assembly in the tunnel complex, recording data, transmission of data).

DNA-012. TITLE: Verification Technology Development
DESCRIPTION: New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations. The problem will basically involve being able to distinguish between permitted activities and prohibited activities where the technical signuatures between the two could be very minor.

DNA-013. TITLE: Nuclear Weapon Effects on Propagation
DESCRIPTION: The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of electromagnetic radiation with a nuclear perturbed atmosphere. Our basic missions to predict effects on and determine mitigation methods for DoD systems include but are not limited to satellite communications, VLF/LF communications, HF/VHF communications, radar systems and sensor systems. Areas of interest include mechanisms coupling nuclear weapon energy to the atmosphere; physical and chemical phenomena arising from nuclear detonations; natural analogs of nuclear environments and processes; predictions of the performance of communications, optical/IR/ultraviolet, radar and directed energy systems in the nuclear

environment; techniques to mitigate nuclear effects on DoD systems as mentioned above; unique instrumentation to measure or simulate nuclear effects and MHD-EMP; and experimental proposals to study naturally disturbed atmosphere as it would relate to nuclear environments.

DNA-014. TITLE: Tactical Application of Pulsed Power Technology DESCRIPTION: Recent advances in energy stage and switching now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor, mine-countermine, anti-submarine technology, high power microwave weapons, etc. Concepts proposed should be highly innovative and make full use of the emerging pulse power technology.

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Phase I proposals (five copies of the full proposal, plus three copies of Appendices A and B only) should be sent by US mail addressed to :

Strategic Defense Initiative Organization
ATTN: T/IS/SBIR
The Pentagon
Washington, DC 20301-7100

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient. US Postal Service Express Mail is the only express service with unconditional access.

Receipt of proposals will be acknowledged only if the proposal includes a self addressed stamped envelope and a form (like Reference B) that needs only a signature by SDIO.

Topics on the following pages are broad statements of SDI interests. SDI seeks innovative concepts on the cutting edge of technology that might enable a defense against a missile in flight. SDI seeks concepts for its general technological need of lighter, faster, smarter, more reliable components. The proposer need not know details of possible SDI systems.

SDI SBIR seeks a demonstrable product that makes a leap in capability - components that might fit into a larger design. SDI seeks to invest seed-capital, to supplement private capital, in a product with a future market potential and a measurable SDI benefit. New algorithms and computer codes qualify if the Phase 2 product would be used extensively outside the firm. SDI SBIR will not fund ordinary research or studies (including technical assistance, surveys and assessments, data collection, or systems studies). Nor will it further develop already mature concepts.

Phase I will show the concept feasibility and the merit of a further investment in a Phase II that will demonstrate a prototype or at least show proof-of-principle. The concept development must be within the scale appropriate for a small firm.

SDI will invest in small firms where the Principal Investigator is primarily employed. Tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any request for waiver must be stated explicitly with a justification showing a compelling national need. SDI expects to grant no waivers.

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Titles of Strategic Defense Initiative Organization
FY1989 SBIR Topics

SDIO 89-001. Title: Directed Energy Concepts

DESCRIPTION: Innovative research in the generation and propagation of directed energy plays an important role in the determination of effective ballistic missile defense systems. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, and free electron lasers. Hybrid approaches are also of interest. Interests in the concepts include the full range of embodiments, i.e., low mass spaced-based, ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, and countermeasures. Approaches are needed that either extend or improve the present concepts. Approaches that facilitate or support the evaluation of concepts are also appropriate.

SDIO 89-002. Title: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons systems are an integral part of candidate strategic defense systems. System candidates presently include ground-based exoatmospheric re-entry vehicle interceptors (ERIS) and space-based interceptors (SBI), high endoatmospheric defense interceptors (HEDI) and hypervelocity guns (HVG) [electromagnetic (EM), electrothermal (ET), and hybrid systems].

Approaches are sought which extend, facilitate, or reduce the cost of the concepts. Elements of the systems include the space-based carrier vehicles (CV) or ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: SBI acquisition of booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C. G. Control algorithms, fast frame and U.V. seekers, acquisition and track; ERIS target discrimination, seeker operational environments, lethality/miss distance; HEDI aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermo-structural integrity, non nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control, and projectile launch survivability; and, common among all systems, reliability, producibility, maintainability, and low cost/low mass.

SDIO 89-003. Title: Sensors

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), superconducting focal plane detector arrays (for both the IR and sub-mm

spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based SDI application (uv-sub-mm wave). Entirely new approaches as well as approaches that expand and improve present concepts are solicited.

SDIO 89-004. Title: Nuclear Space Power

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for both manned and unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include: thermoelectric, thermionic, and Brayton cycle. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 89-007, innovative high power thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO 89-005. Title: Non-nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO 89-004, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO 89-006. Title: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operations of the spacecraft have been major factors in determining the life cycle costs of space-based assets. This burden on the deployment of strategic defense systems has been identified a major cost driver. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluents, and sensors and controls for autonomous operation.

Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of the SP-100 reference mission incorporating arcjet thrusters, attention is being directed at thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit).

SDIO 89-007. Title: Thermal Management

DESCRIPTION: The high power levels for space stations will need effective heat dissipation. Expected power levels required for SDI space platforms will stress state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems and space platform payloads.

Some space platforms will require long term (years) storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under conditions of zero -g, microgravity and maneuvering loads. Innovations are sought for concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

SDIO 89-008. Title: Survivability

DESCRIPTION: The various components of a space-based missile defense system must survive both attack and the environment in space. Products, processes, and techniques for active and passive hardening against directed and kinetic energy devices, and natural threats such as UV/radiation damage, thermal cycling, and atomic oxygen degradation are sought. Components to be made survivable include sensors, battle management systems, power systems, and directed/kinetic energy weapon configurations. Survivable sub-components include large and small optics, electronics, structures for support and fuel containment, and specific materials critical for shielding, maneuvering, propulsion, and targeting. In addition to shielding, other well designed and innovative countermeasures are encouraged. Specific examples of areas to be addressed include thermo-mechanical shock hardening, heat dissipation techniques, protective coatings, baffling techniques, materials conditioning, orientation or deployment strategies, insulation methods, threat radiation activated optical limiters and switches, and the non-linear optical materials/techniques involved in their fabrication. Of particular interest is hardening and survivability against x-ray lasers and bright short wavelength ground-based lasers.

SDIO 89-009. Title: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. Innovative ideas or concepts for measurement of radiation or particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off. New concepts to produce higher probability of kill-given-a-hit.

SDIO 89-010. Title: Computer Architecture, Algorithms, and Language

DESCRIPTION: Strategic defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.

- Language design to develop code optimized for highly parallel processed architectures.

- Testing techniques that will provide a high level of confidence in the successful operation of extremely large software systems.

- Computer network and communications security. R&D for trusted computer systems in accordance with DOD 5200.28.STD; integration of COMPUSEC with COMSEC (DOD 5200.5).

- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.

- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for desision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

SDIO 89-011. Title: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

SDIO 89-012. Title: Space Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vessels. All of these present individual challenges in terms of stiffness, impact resistance, high temperature

capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Techniques for both passive and active control of the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression. There is also a need for novel, lightweight large optical structures that are compatible with the space environment, and for innovative optics/information processing techniques which maximize the imaging performance that can be achieved with imperfect, temporarily unstable structures.

SDIO 89-013. Title: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 89-012 will depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Specific goals requiring advanced techniques and processes include imparting oxidation resistance and damage tolerance to composites, enhancing the static and dynamic toughness of ceramic composites, and creating fatigue-resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to establish the thermodynamics and kinetics basis for minimizing fiber-matrix reactions in composites exposed to high operating temperatures. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, low density alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. Proposals involving these as well as other space structure and material-related research and innovative technology topics are encouraged.

SDIO 89-014. Title: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/super lattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many SDI electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

SDIO 89-015. Title: Superconductive Materials

DESCRIPTION: Recent advances in the discovery and fabrication of high-temperature superconducting materials promise to have a large pay-off for many SDI applications. Interest in these new materials includes material characterization, stabilization of new high-Tc phases, and development of novel fabrication techniques for both the thin-film and bulk materials. Areas of application are also being stressed and include: novel, low-power infrared (IR) staring-array sensors, particularly those with monolithic focal plane pixel arrays and read-out electronics; high-Tc superconductive materials for various electronic applications, e.g., Josephson junctions and SIS mixers; bulk materials for power transmission, conditioning, and storage; compact, high-gradient accelerator cavities for novel particle beam and free-electron laser design concepts; magnetic shielding of critical components from EMP effects. Note that in the applications area interest is not limited to only this new class of high-Tc superconductors but attention is also given to the more mature low-Tc materials as well, e.g., Niobium and Niobium Nitride.

Reference A

PRIOR YEARS RESULTS OF DOD SBIR PROGRAM

FY 83 - FY 87	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	959	6731	876	270
Navy	869	5880	786	238
Air Force	1041	6668	1167	373
DARPA	97	937	146	40
DNA	40	634	109	17
* SDIO	44	1639	502	52
	3,050	22,489	3.586	990**

FY 88	Number of Topics	Proposals Received	Number Selected For Phase I Negotiations
Army	234	2425	225
Navy	250	2022	195
Air Force	242	2707	371
DARPA	38	555	62
DNA	8	186	19
SDIO	15	730	137
	787	8,625	1009***

* SDIO began participation in FY 1985.
** Awards made as of August 1988.
*** Selections as of August 1988.

Reference B

TO: ____

(Fill in firm's name and mailing address)

SUBJECT: SBIR Solicitation No. 89.1

Topic No. ______________________

(Fill in topic no.)

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____

(Fill in name of organization to which you will send your proposal.)

____________________________________ __________

(Signature by receiving organization (Date)

Reference C

TO: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form (or a facsimilie), fold, stamp and mail. Please bear in mind that significant mailing delays can occur in December.

DTIC authorization to provide this service expires January 6, 1989, the DoD SBIR Program Solicitation closing date.

REQUESTER ____
Name

ORGANIZATION NAME ____

ADDRESS ____
Street

____ **PHONE** _____/_____-__________
City State Zip Code Area Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1 ________	6 ________	**PLEASE TYPE OR PRINT IN THE ORDER TOPICS APPEAR IN THE SOLICITATION**	11 ________	16 ________
2 ________	7 ________		12 ________	17 ________
3 ________	8 ________		13 ________	18 ________
4 ________	9 ________		14 ________	19 ________
5 ________	10 ________		15 ________	20 ________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in section 2.2 of the DoD Program Solicitation No. 89.1

This is our first request during the current solicitation: yes___no___ .

____
Signature of Requester

Fold

Staple

Stamp

Return Address

Defense Technical Information Center
Building 5, Attn: SBIR
Cameron Station
Alexandria VA 22304

Fold

Reference D

Director of Small and Disadvantaged Business Utilization (SADBU) Specialists assigned at Defense Contract Administration Services Regions (DCASR) and Defense Contract Administration Services Management Areas (DCASMA):

DCASR Boston
495 Summer Street
Boston, MA 02210-2184
Tel: (617) 451-4317
ATTN: Edward Fitzgerald

DCASMA Boston
495 Summer Street
Boston, MA 02210-2184
Tel: (617) 451-4109
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ATTN: Robert Hunter

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(212) 807-3050/3051 (commercial)
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Tel: (203) 385-4412
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Garden City, Long Island, NY 11530-4761
Tel: (516) 228-5724
ATTN: John Richards

DCASMA New York
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New York, NY 10014-4811
Tel: (212) 807-3314/3315
ATTN: John Castellane

DCASMA Springfield
240 Route 22
Springfield, NJ 07081-3170
Tel: (201) 564-8204
ATTN: Charles Ferraro

DCASR Philadelphia
2800 South 20th Street
Philadelphia, PA 19101-7478
Tel: (215) 952-4006/4007
ATTN: Roger Rhyner

DCASMA Philadelphia
2800 South 20th Street
P. O. Box 7699
Philadelphia, PA 19101-7478
Tel: (215) 952-5818
ATTN: Julia Graciano

DCASMA Reading
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Reading, PA 19602-1094
Tel: (215) 320-5012
ATTN: Thomas Knudsen

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Federal Building
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Pittsburgh, PA 15222-4190
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ATTN: John Bauer

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Towson, MD 21204-3099
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Chicago, IL 60666-0475
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(312) 694-6020 (commercial)
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Building 1
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AJC Federal Office Building
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Tel: (216) 522-5122
ATTN: Wilma Combs

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AJC Federal Office Bldg.
1240 East 9th Street
Cleveland, OH 44199-2064
Tel: (216) 522-5446
ATTN: Herman Peaks

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1507 Wilmington Pike,
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477 Michigan Avenue
Detroit, MI 48226-2506
Tel: (313) 226-5180
ATTN: Dave Boyd

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Riverview Center Bldg.
678 Front St., NW
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49504-5352
Tel: (616) 456-2620
ATTN: Kay Hamilton

DCASR St. Louis
1136 Washington Ave.
St. Louis, MO 63101-1194
Tel: (314) 263-6617
ATTN: Thomas Moore

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St. Louis, MO 63102-1181
Tel: (314) 263-0908
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Cedar Rapids, IA
52402-1251
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Wichita, KS 67209-1988
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Bldg. 5 - Suite 250
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805 Walker Street
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Suite 104
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Tel: (205) 226-4304
ATTN: Lola Alexander

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3555 Maguire Blvd.
Orlando, FL 32803-3726
Tel: (305) 228-5113
ATTN: Russell Nielsen

DCASR Los Angeles
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El Segundo, CA 90045-4320
Tel: (800) 233-6521 (California only)
(800) 624-7373 (all others)
ATTN: Skip Kakstadt (Acting)

DCASMA San Diego
7675 Dagget St., Suite 200
San Diego, CA 92111-2241
Tel: (619) 260-2007
ATTN: Bob Hodby

DCASMA San Francisco
1250 Bayhill Dr.
San Bruno, CA 94066-3070
Tel: (415) 872-9523
ATTN: Robert Lane

DCASMA Santa Ana
34 Civic Center Plaza
P. O. Box C-12700
Santa Ana, CA 92712-2700
Tel: (714) 836-2913
ATTN: Robert Berger

DCASMA El Segundo
222 N. Sepulveda Blvd.
El Segundo, Ca 90245-4320
Tel: (213) 335-3509
ATTN: Ruby Morris

DCASMA Van Nuys
6230 Van Nuys Blvd.
Van Nuys, CA 91401-2713
Tel: (818) 904-6158
ATTN: Shirley Johnson

DCASMA Seattle
Bldg. 5D - US Naval
Station - Puget Sound
Seattle, WA 98115-5010
Tel: (206) 526-3451
ATTN: Alice Toms

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